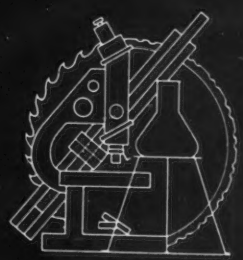
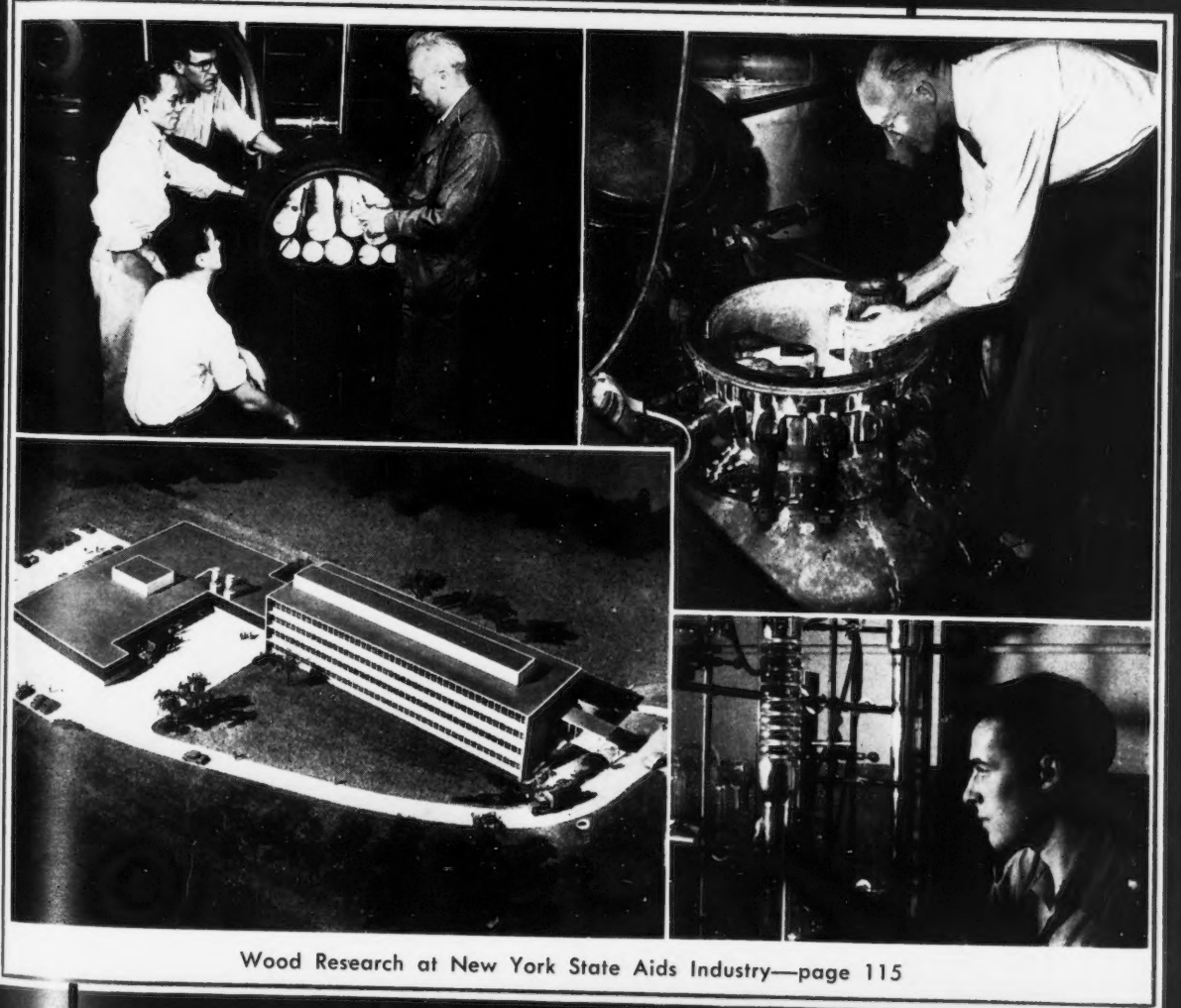
Journal of the Forest Products Research Society



Vol. IV, No. [illegible] June, 1954



Wood Research at New York State Aids Industry—page 115

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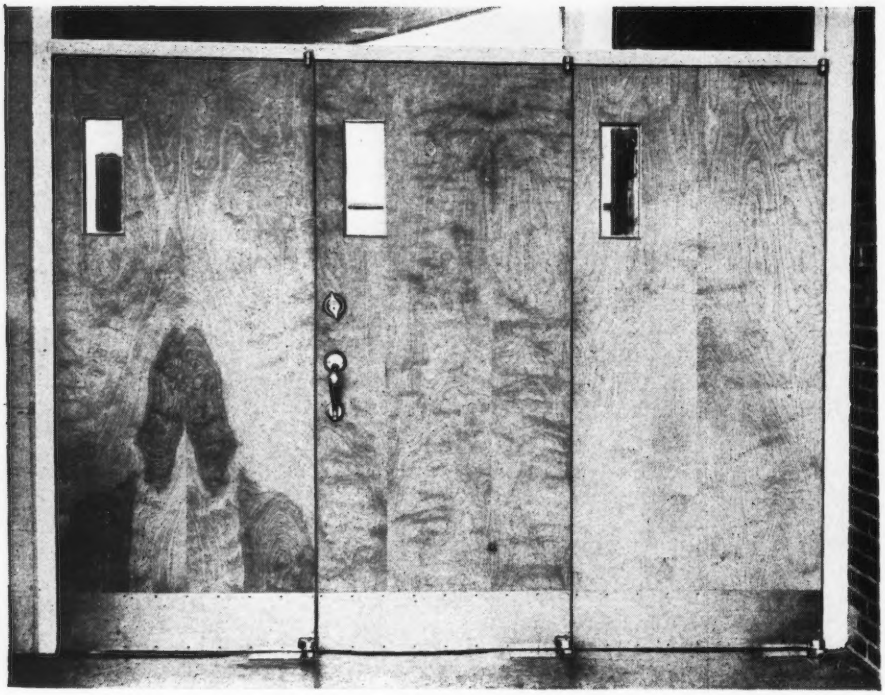

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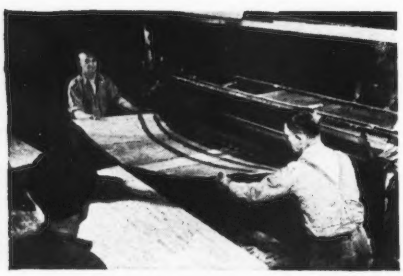

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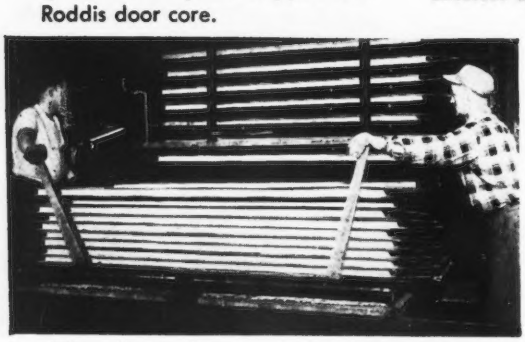

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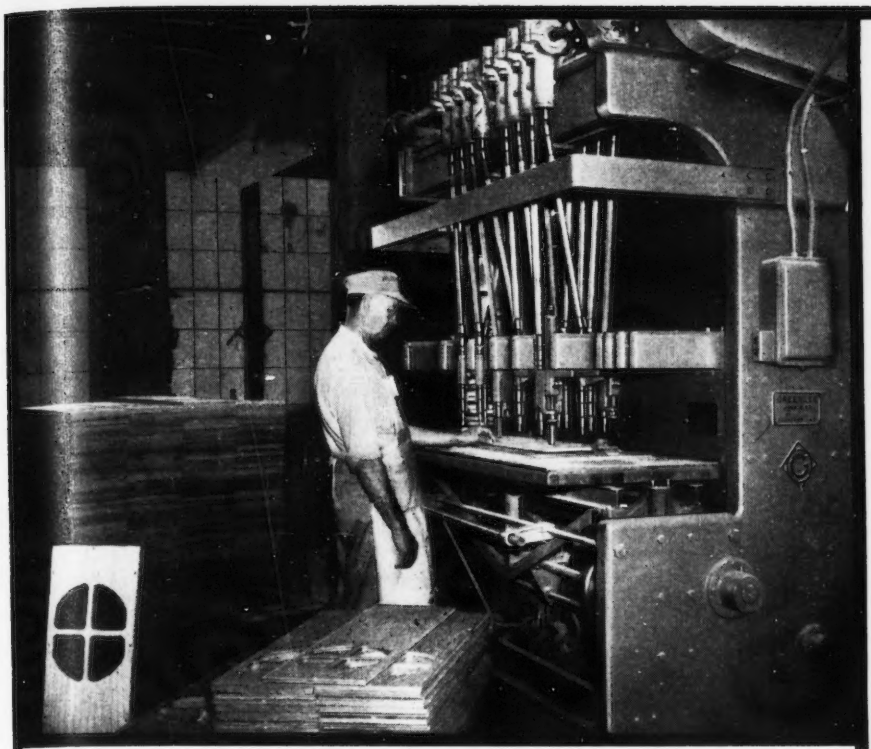

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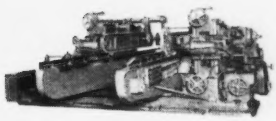

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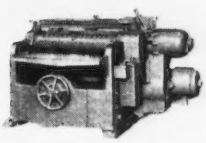

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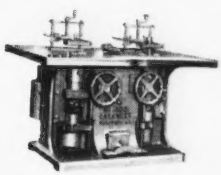

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JOURNAL OF THE FOREST PRODUCTS RESEARCH SOCIETY

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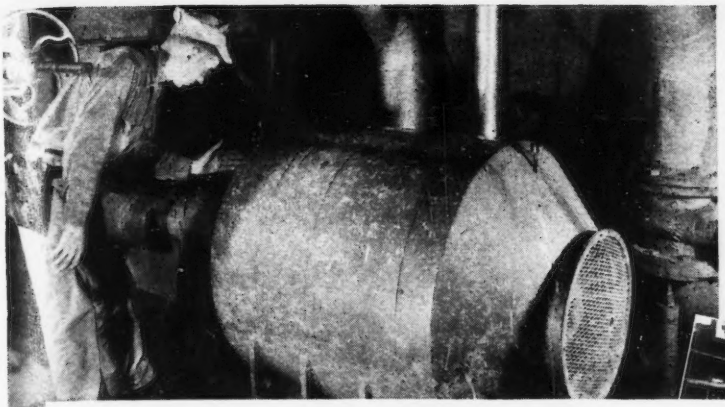

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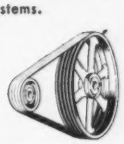

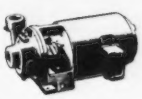

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(Continued on page 39-A)

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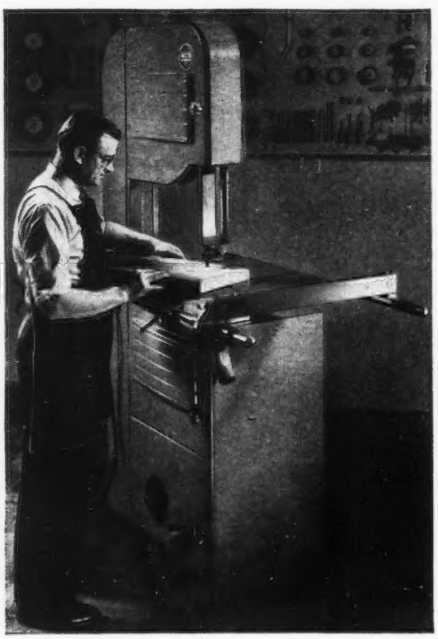

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Let's Help the Wood Industry to Help Itself

FRANK T. PARRISH

Northeast Regional Board Member of F.P.R.S. and National Membership Chairman

F. T. PARRISH

THE GUEST EDITORIAL for the April Journal written by T. J. Connelly, president of the Dean Company, was a sound constructive challenge to our wood industry. It suggested that all engaged in wood fabrication, or related fields, evaluate themselves, asking "Are we good enough in research and marketing to maintain our just share of business in the world market?"

Let's not fool ourselves, all of us in the wood industry are really in big league competition with strong hard hitting competitors that see to it that "Research" has been moved into the clean up spot in their batting order coupled every time with a hard hitting marketing program. Such a combination is sure to score runs.

All this leads up to my subject at hand, "Let's Help The Wood Industry to Help Themselves" through membership in F.P.R.S.

As your 1954–55 National Membership chairman, I have a special interest in exposing our "product" (membership in F.P.R.S.) to every segment of the wood industry in the U.S.A., in each of our 13 sections and in Canada.

All woodworking groups are aware of their need for a lot of batting practice to sharpen their eye on new techniques, methods and other new developments.

The Frampton Committee Report has done much to make all very self-conscious of the need for a wood industry move in the direction of "Research" and, not, as in the past, tend to shy away from it.

Bob Pauley made mention of some very timely facts in regard to this same subject in his last President's column in the April issue of the Journal that would bear reading, or re-reading by all members and particularly membership workers.

We have a "package deal" in F.P.R.S. membership that will return to a new member the yearly cost beyond any shadow of doubt. For this reason we have a wanted item and it is up to all of us to expose it and to sell it to the Industry.

Membership in the F.P.R.S. promotes the latest in Research, Development, Production and Utilization in every phase and operation connected with the wood industry.

Let us touch for a moment on the word Research. To a large number of smaller woodworkers in the country the mention of this expensive sounding word "Research" always scares them. Let us be sure we let our potential customers know that we in F.P.R.S. generally talk in every day language of just plain "find out" at both our meetings and in our printed matter. This inexpensive "find out" theme is certainly substantiated in the fact that our F.P.R.S. membership is only $15.00 per year (with barrels of Research thrown in at no extra cost!)

Now to some of the plans for the coming year as to our new membership approach in each of our sections by the section officers and membership committee and/or chairmen of same.

First our objective—"3,000 or more thru '54". This should be easy when you consider for example there are that many furniture companies alone in the country (each one of which *should* have one membership in F.P.R.S.) and probably 10 times that many sawmills in the country both large and small! Adding these to all the related material, and machining suppliers to the wood industry, totals to an astounding potential.

Twelve interested membership chairmen and officers of the different sections, meeting at a 7:30 "organization breakfast" in Grand Rapids, considered the approach to these many potential customers and discussed a number of good plans which we hope to inaugurate. Here are some that are now in the embryo stage which we plan to shortly nurse to maturity.

While most of this is directed at Section Officers, Membership Chairmen and Committees, nevertheless I want to consider each and every one of you F.P.R.S. members that read this a committee of one to contact a new member. Help your own section keep up at the top of the league standing!

(1) A Monthly League Standing of New Membership. (This is to be by sections—posted standings will be against their quota—probably an average of 20% of existing membership as the 1955 goal.) Just think, if all make the quota our National membership will double in some less than every 5 years—so we *could* have 32,000 members by 1970! Prizes for the season's winning section will be announced. The thought so far is for winning membership chairman and committee or officers to get *free* registration to 1955 National Meeting!

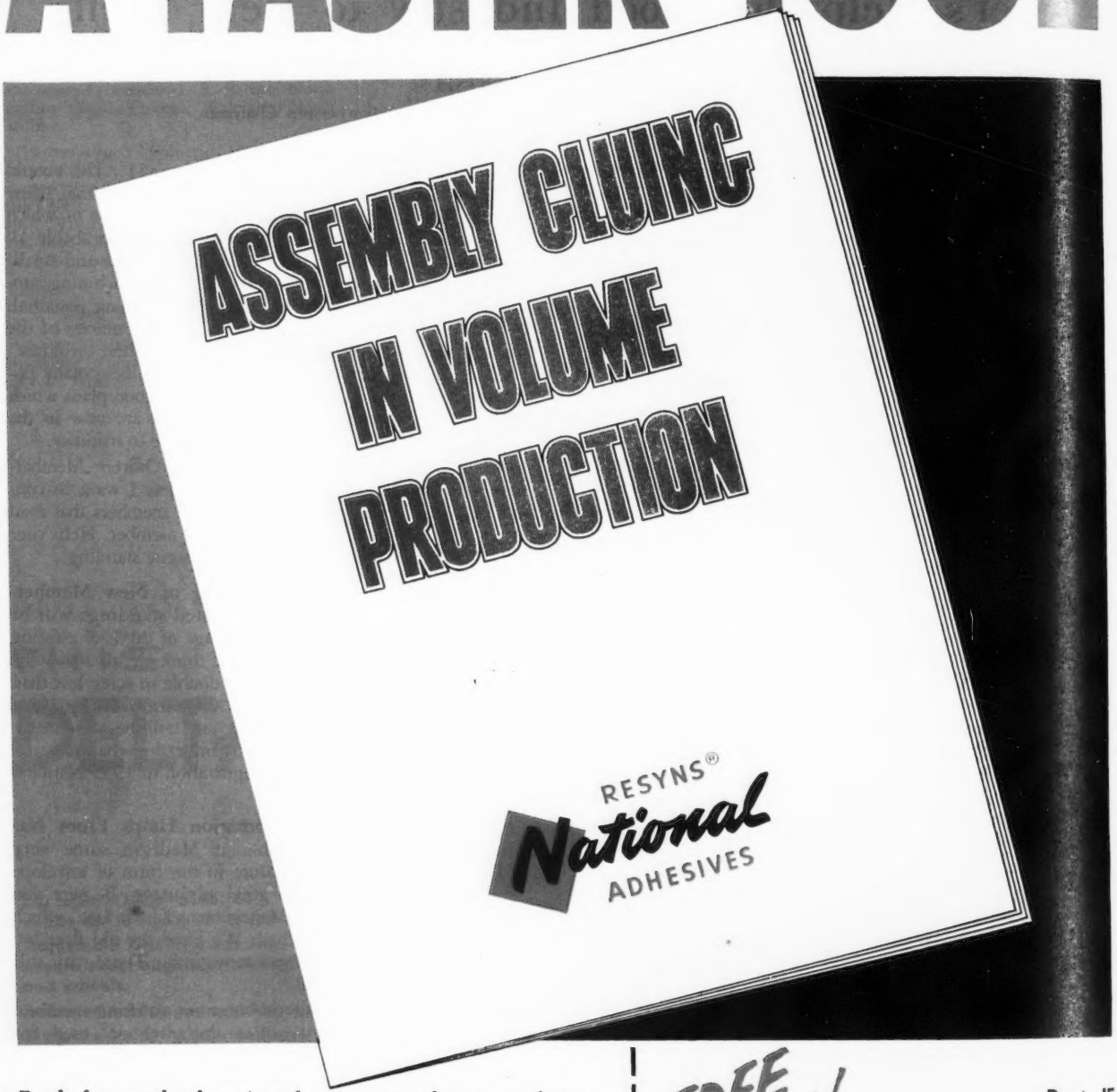
(2) New Membership Promotion Helps From National. There is now available at Madison some very good, simple easy to read literature in the form of envelope stuffers which can be used to good advantage. Be sure you all have a supply of "Wood Management Check List" which has an easy order blank attached. We liked the old flyer too and used it to good advantage many times. There may still be some of them left as well.

It is also planned to print one new eye catching membership publicity flyer. The "million dollar check" used for several years by the Northeast worked well, and Paul Graham has a new idea (that was suggested National use for all sections). This is a cutout in the form of a key and when addressed to a prospective member would read—"A membership in F.P.R.S. is the key that unlocks your door to better Wood Research, Development, Production and Utilization, etc., etc." This might be called a "gimmick" but we know it will pay dividends.

(3) Chart Your Section Membership on a Map. There is nothing like a map of your section studded with membership pins to create interest at meetings. New prospective members like to see where their nearest neighbor-member lives. It is also good for organizing too and will show at a glance where the weak points and strong points exist in a section. Also be sure each membership chairman, officer or ones working on membership have a copy of the Geographic Directory of Members that is available from Madison.

(Continued on page 40–A)

A FASTER TOOL



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Wood Products Research At the State University of New York College of Forestry

JEROME G. KOVALCIK

Assistant Professor of Forest Extension and Director of Public Relations, Syracuse, New York

Wide range of research activities at New York State College of Forestry are described, as well as the excellent program for sharing the results of research with the public, including wood using industries.

RESEARCH HAS BEEN an important function of the State University of New York College of Forestry since its establishment in 1911. The charter of the College lists among its major responsibilities ". . . the carrying on and promotion of investigation, experiment and research in forestry and its several branches."

Research at the College has grown rapidly in recent years, and now includes important projects in all major fields of forestry. About half of the research is supported by the College budget. The remainder includes research sponsored by industry (70%), government agencies (20%), and foundation grants (10%).

The research program of the College is administered by Dr. Edwin C. Jahn, Associate Dean for Physical Sciences and Research. The research budget, research staff and sponsored research are administered through his office. His office also serves to coordinate and assist the research of individual faculty members. The latter studies as well as the work of graduate students are administered by College departments.

There are twenty-nine full-time members on the research staff supported by the College Research Budget and twelve by sponsored research. These figures exclude fellowship holders.

Legally the College's research program is operated by the State University of New York and the Research Foundation of the State University. Its policy is geared to that of these organizations. Emphasis is placed upon research which is basic and fundamental. No classified research is carried out, except occasionally upon request of the Department of Defense.

The College believes that present efforts in research need to be multiplied several times to meet present and future needs. It looks forward to an expansion of its program with the construction of a new Wood Products Laboratory building scheduled to begin this year at an estimated cost of $3,000,000.

Research is being conducted in the several fields of forestry and related areas: management, economics, silviculture, landscape architecture, wildlife problems, entomology, botany, chemical debarking, wood technology, utilization of wood products, pulp and paper technology, and chemistry.

Although research in the first five of these fields is indirectly and fundamentally related to studies in wood products, the last seven pertain more specifically and immediately to any discussion of wood products laboratories.

Entomology

Two studies are most relevant to a treatment of wood products laboratories: one by Prof. Aubrey H. MacAndrews of the extent of injury to logs caused by ambrosia beetle attacks; and another by John P. Simeone of insects causing the deterioration of wood with emphasis on the relative economic importance of the different species, their ecology, and the adaptation of ecological principles toward preventive control measures.

A greenhouse and insectary permit biological studies in the winter. Controlled-temperature equipment permits studies in cold hardiness and hibernation and in life cycles and analysis of climatic factors.

The College's insect collection contains 400,000 specimens. Twenty-two thousand acres of College-maintained forests provide field study laboratories.

Botany

Studies on fungi causing decay of timber and wood products have been actively pursued over several years. Among these are the work of Dr. Josiah L. Lowe on the identification and classification of woodland fungi with emphasis on those causing disease in trees and deterioration of wood products; and the testing of eastern white pine resistance to the blister rust pathogen by Dr. Ray R. Hirt.

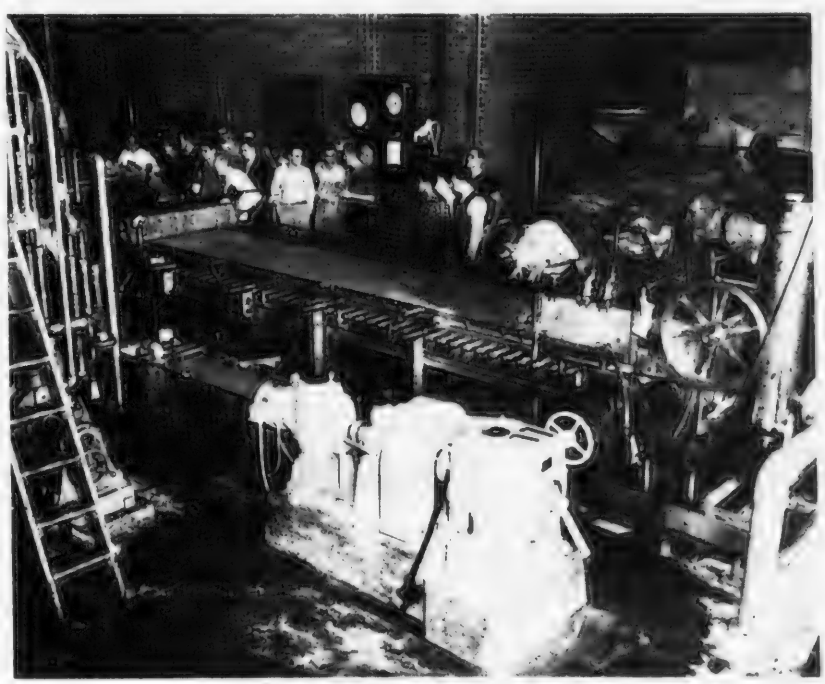

Figure 1.—Class watches paper making process on school equipment.

COVER PHOTOS—Lower left: New research building currently under construction. Upper left: part of wood treating facilities; upper right: hardwood logs being placed in digester for trial cook; and lower right: fractional distillation (hi-powered still) apparatus.

A study of the control of blue stain in white pine lumber during seasoning in the Northeast has been made by Dr. Robert A. Zabel. He has also studied the control of decay and stain that develops in hardwood logs in storage. Currently he is studying the evaluation of arsenicals for slime control in pulp mills, a project sponsored by the American Smelting and Refining Company; and special studies of fungicides in wood products, sponsored by the U. S. Quartermaster Corps.

Dr. Savel B. Silverborg has recently collected, identified, and studied wood decay fungi from houses and industrial buildings in New York State. He has evaluated various preservatives for the control of decay in native American woods for use in seed flats, greenhouse benches, and house construction. He has also completed a study of cull in hardwoods of the Northeast in relation to external evidences on the living tree.

Future research plans related to products include intensive studies in control of wood deterioration; slime control in pulp and paper mills; the progress of disease in forest plantations of New York State; mycological studies of wood destroying fungi; and disease resistance.

Laboratories include a greenhouse, wood decay room, physiology dark room, and thermostatically controlled coldroom. Laboratory equipment includes specialized apparatus for botanical research.

Figure 2.—Research projects are carried out in the forests as well as in the laboratory.

Chemical Debarking

To learn more about factors influencing chemical debarking, to determine the movement and distribution of the chemical in the tree, and to ascertain its effect on the living tissues, a group of fourteen pulp and paper and chemical companies has been sponsoring a broad systematic study of the problem at the College. Intensive work on the College's Huntington Forest combined with that of the cooperating sponsors on company lands at ten locations in New England, New York, and Pennsylvania has proved that chemical debarking is a useful tool, not only of practical value in planning and executing logging schedules, but in silvicultural treatment of the forest. The members of the Chemical Debarking Research team have been Dr. Hugh Wilcox, Physiologist, Project Leader; Dr. Felix Czabator, Pathologist; Dr. Robert Smith, Biochemist; Dr. Guido Girolami, Anatomist; Dr. William L. Webb, Wildlife Zoologist; Dr. Merritt McGahan, Anatomist; Donald Moreland, Physiologist; and Margaret Grisdale, Botanist.

Wood Technology

Fundamental studies of the microscopic structures, properties, and characteristics of wood together with work on growth-quality relationships are carried on in the wood technology laboratories under general direction of Dr. Eric A. Anderson. The research parallels training offered in engineering of wood structures, wood physics, anatomy of wood, strength properties, and identification of wood.

The main research project now in progress is a study of the behavior of wood subjected to sonic and ultrasonic sound waves by Richard E. Pentoney who is attempting to determine the internal friction and certain strength properties of wood by non-destructive means. Plans are formulated to follow the progress of certain chemical reactions, particularly gelation, by means of ultrasonic wave propagation.

A study of compression wood in plantation-grown red pine to determine the incidence of this type of abnormal wood at different growth rates, degrees of lean, and heights in tree is being made by Harold A. Core. An investigation of rapidly-grown Douglas fir is being carried on in cooperation with the Oregon Forest Products Laboratory.

The strength properties of wood are being studied by Dr. Carl H. DeZeeuw. Special lines of investigation are the relation of wood structure to strength and the impact-dynamic strength relations in wood. He also supervises the collection of authenticated wood specimens, a program initiated by the late Dr. Harry P. Brown, including about 13,000 specimens from all over the world. This collection includes a set of some 900 American species, samples of which have been deposited with many other laboratories throughout the world.

In cooperation with the U. S. Forest Products Laboratory, the College is examining the relation of percent summerwood to specific gravity in fast-growth Douglas fir, together with the specific gravity of the springwood and summerwood of this species. Differential shrinkage properties of wood are under investigation in cooperation with the Canadian Forest Products Laboratory. A key for identification of fibers from common trees of the United States is in preparation.

Future projects of the wood technology laboratory include a study of liquid and heat movement in wood. A publication on Southeastern Asian woods is planned.

Among facilities for research in wood technology are a photographic laboratory for high speed camera work and microtechnique studies; dynamic testing equipment; wood conditioning equipment; testing machines for study of strength properties; and the general wood collection.

Utilization of Wood Products

An extensive program of research in utilization of wood products is being conducted in electronics, woodworking, sawmilling, seasoning, wood finishing, preservation, and industrial engineering laboratories. A moisture and temperature control room supplements these facilities.

John M. Yavorsky, research associate, is conducting full-time laboratory studies in electronics with special reference to glues and adhesives and closely related problems. Several publications on the results of this work have recently appeared.

The electronics laboratory equipment includes a 10-kilowatt radio frequency 24″ x 36″ edge-gluing press, a 5-kilowatt power supply RF heat generator, a portable RF gluer, a 24″ x 4″ cold press, and a Dillon Universal testing machine.

Basic research in the machining of wood is being conducted by Robert J. Hoyle, Jr. Although the study is in the infant stage, it is of interest to machine manufacturers as well as wood working plants. Wilfred A. Cote, Jr. is cooperating in this study by the application of high speed camera photography. It is expected that this tool will be extended to other operations on wood and its products.

The woodworking laboratories, experimental sawmill, dry kiln, industrial engineering laboratory, wood finishing laboratory and preservation laboratory are well equipped and are used not

only for undergraduate instruction, but also for graduate instruction and research. The sawmill, under the supervision of Kenneth C. Compton, is similar to ninety percent of the commercial mills in the United States, and features a guide line apparatus which throws a shadow on boards to help in cutting.

The dry kiln, which is supervised by Harold B. Gatslick, is a converted low-velocity, reversible circulation, forced-draft, end-piled compartment type of 2500-feet capacity with air-operated automatic controllers. It is designed to allow easy access for inspection and circulation and drying studies during the run.

The industrial engineering laboratory has facilities for studies of production control, work simplification, plant layout and material handling, statistical quality control, and statistical aspects of dimension tolerances. This work is supervised by Dr. Aubrey E. Wylie.

Several sponsored research projects in wood products have been undertaken. Among them are studies of the construction of laminated shoe lasts, bushel baskets, and laminated gun stocks, all under the direction of Professor Bishop.

Professor Raymond J. Hoyle, supervisor of wood utilization research, looks forward to greater basic research in the machining of wood. Other future plans include research in noises of woodworking machines, modification of stress-drying schedules, cost analysis in drying, electrical properties of wood, RF assembly gluing for case goods, and water repellants.

Pulp and Paper Technology

The heart of the pulp and paper laboratory is a commercial-type paper mill including a 65-cubic foot pulp digester, a Great Northern type grinder, hydropulper, a 36-2 Sprout Waldron disc mill, a multiple-bed plate Jones Bertram precision beater, refiners, and a 52-inch combination Fourdrinier and cylinder paper machine. Other laboratories are equipped with experimental digesters for the chemical pulping of wood, and facilities for bleaching, pulp purification, refining, and physical evaluation of pulp. Precision testing instruments and dyestuff and chemical laboratories are available.

Recent research has emphasized the pulping of hardwoods. One aspect of this research has been the development of the chemogroundwood process by Professors C. E. Libby, formerly of the College, and Frederic W. O'Neil. The process is especially adaptable to hardwoods, although certain softwoods react favorably. The Great Northern Paper Company in Maine is building a chemigroundwood plant with over 350-ton daily capacity.

The hardwood pulping studies are a cooperative venture with the Empire State Paper Research Associates, Inc. (ESPRA), supported by twenty companies including three in Canada, and four in Europe. ESPRA is cooperating in attempts to find better ways of making paper pulps, especially from hardwoods. This work is under the direction of Dr. Robert M. Husband, who has recently published new findings on the pulping of hardwood chips.

During World War II the laboratory was also used for the manufacture of battery-plate separators from redwood bark fiber for the U. S. Government.

The pilot plant is a means for carrying out industrial service work for the pulp and paper industry. It permits use of the College's unique facilities, such as the paper machine, for trial and development studies. A special group of personnel under the direction of Robert G. Hitchings, assisted by Graham H. Ireland, carries out this program. Contracts are made between an industry and the Research Foundation of the State University of New York. The industry is charged the cost of operation in each case.

The pilot plant program has been in operation for but one year and already studies have been carried out for the U. S. Department of Agriculture concerning the making of paper and box boards from a combination of straw and bagasse pulps with wood pulps. Various technical problems related to pulping, papermaking, and the addition of materials to paper have been studied for industry.

A new pulping process and advanced methods of pulp purification with oxidizing agents are being investigated by Professor Carmin P. Donofrio.

Dr. Vivian T. Stannett and Professor S. Earll Church are carrying out studies involving application of resin and latices as beater additives and coatings. This work is supported by a grant from the Durez Chemical and Plastics Company. A broad program of research on paper-plastics combinations is under way. Dr. Stannett is conducting the work on grants from the Monsanto Chemical Company and National Starch Products Company.

Dr. Gordon Moulds is investigating the holocellulose of Norway spruce, especially the mannan fraction, as a probable aid to the preparation of pulps for rayon, cellophane, and plastics.

Chemistry

The College has laboratories for instruction in cellulose chemistry and plastics technology. There are also additional staff and graduate student laboratories for research on the chemistry of wood and on natural and synthetic polymers.

A rather large and intensive investigation on the permeability of polymer films and resin-treated papers is being carried out by Dr. Michael M. Szwarc and Dr. Vivian T. Stannett. Their work is supported by grants from the Technical Association of Pulp and Paper Industry, the Office of the Quartermaster General, and the Polaroid Corporation.

Dr. Stannett is studying the kinetics of polymerization and the degradation of plastics during molding.

Sponsored by the National Science Foundation and the Research Corporation, a study of the energy of dissociation of chemical bond is being conducted by Dr. Szwarc.

Work on the chemistry of lignin under the sponsorship of the Research Corporation and the Technical Association of Pulp and Paper Industry is being done by Dr. Conrad Schuerch, Jr. He is also studying certain problems in hemi-celluloses. This work is supported by the Ordnance Division of the U. S. Army.

Basic studies in the chemistry of cellulose and cellulose derivatives are under

Figure 3.—Improvements in wood products technology are shown to visitors at New York State Fair at Syracuse.

investigation by Dr. C. Vernon Holmberg and Dr. Edwin C. Jahn. Some of this work is sponsored by the American Viscose Company and the Celanese Corporation.

The formation of complex molecules between cellulose and synthetic polymers is an important aspect of the program, studied by Dr. Irving Waltcher.

Since the chemistry program is but two years old, expansion is anticipated when construction of the new building will make available additional space for improved equipment.

Future plans include developing research in photo-chemistry. It is expected that ultimately this research will deal with photosynthetic problems. Research in radioactive materials will also increase and the College has had a member of its research staff at Brookhaven National Laboratory, of the Atomic Energy Commission, for the past two years. Ultrasonic waves are expected to be used in the study of various chemical problems dealing with cellulose, lignin, and polymers.

Extension Program

The College's extension department coordinates means of sharing results in wood research with the public, including the wood industries. Technical, semi-technical and popular information publications on all aspects of forestry are issued regularly. Numerous scientific articles by College faculty appear in journals, and graduate students' theses are available at the library.

The College has a full-time industry service representative, Professor Russell C. Deckert, who contacts members of wood industries within New York State and offers assistance in their every-day problems.

A wood utilization Marketing Bulletin has been published by Professor Raymond J. Hoyle for more than 30 years. Issued every six weeks, it is sent free of charge to over 3,000 individuals and organizations in New York State and the northeastern section of the United States.

Close contacts are also maintained with other types of industry such as the pulp and paper industry. Departmental offices frequently provide a setting for College-industry meetings. Many questions concerning wood products manufacture are answered by mail.

In the past year the College's Industry Short Course program has included nine annual regularly scheduled short courses. Usually of one week's duration, they are designed for men in the wood industry. Among the courses are those in quality control, wood gluing, hardwood lumber grading, properties and characteristics of wood, dry kiln operation, care and maintenance of carbide-tipped cutting tools, operation of small sawmills, and photogrammetry.

In addition to the regularly scheduled courses, conferences and short courses have also been held in cooperation with the National Furniture Manufacturers Association and the Jamestown Area Furniture Manufacturers Association.

The New Wood Products Laboratory

No account of Wood Laboratories at the State University of New York College of Forestry would be complete without a description of the new Wood Products Laboratory building whose construction will begin this year. Very many of future plans for research in wood products depend greatly on the projected facilities.

The new L-shaped structure will include a four-story section and a one-floor shop wing. With 88,000 square feet of space, it will be the largest at the College. Bray Hall, built in 1917, has 69,984 square feet, and Louis Marshall Memorial, built in 1932–33, has 76,367.

The foyers and staircases will be paneled in oak. The bridge, which will permit entrance onto the third floor, will be of wood; so will most doors, three conference and library rooms, three clerical offices, three department chairmen's offices, the student lounge, reception area, and staircases. The three office, library, and conference rooms will have panels of birch, maple, and cherry, native New York hardwood species.

The building itself will cost approximately $2,225,000. Laboratory furniture is expected to amount to $275,000, and heavy attached equipment over $500,000. Office furniture and unattached equipment will cost $140,000.

Space does not permit a complete listing of facilities and equipment for the new building. A treatment of a few of the more important items, as now envisioned, is in order.

In the veneer and plywood laboratory there will be a lathe with a 54″ knife and 36″ swing which will handle bolts of a minimum length of 16″. It will be possible to produce veneers of 20 different thicknesses. Speeds from 300 to 1,200 rpm will be possible. With versatility of equipment as a keynote, there will be variable speed D.C. motors and separate D.C. generator sets for each motor driven unit. A wet veneer clipper with a knife operating at 250 strokes a minute will be controlled by push buttons. A new veneer clipper attachment, dryer, and splicer, together with a glue mixer and spreader and a plywood press, will also be included.

A 400,000 lb. Universal testing machine with an integral and long bed will feature the mechanics and physics laboratory. The machine is a new development in wood testing and still is in the design stage. Another new type of machine to be installed is a Baldwin FGT machine which can develop stress-strain relations in wood in alternate tension and compression at low speed rates. A stress-strain recorder on the machine will be operated electronically. Three additional testers, 120,000-lb., 50,000-lb., and 5,000-lb., will round out the equipment.

The research surfacer in the wood working laboratory will have a feed of 20 to 60 feet per minute. Its cutting speed will be 1,000–20,000 rpm. With mounted tachometers, the research jointer and table saw will be able to handle stock at speeds varying between 1,000 and 20,000 rpm.

The wood preservation laboratory will include five impregnating cylinders, vacuum pumps, five 1,000-gallon storage tanks, and a 1500-gallon sump tank.

There will be five dry kilns with gas and steam heating. Construction will be of such nature that experiments with new types of heating will be possible. Humidity and ventilation controls, fans, electronic recorders, and steam flow meters will add to the improvements.

Three rooms will be provided for testing plywood, preservatives, and moisture. There will also be five temperature and humidity control rooms.

The timber preparation laboratory will house a sawmill and associated equipment. The mill is a left-hand one with a 54″ saw, operated by a 76 HP D.C. motor. By various controls it will be possible to develop mandrel speeds of from 300 to 1,200 rpm. Oscilloscopes and other devices will provide for records of saw torque and carriage pull. A special bearing will record horizontal and vertical pull on the mandrel. The sawmill carriage will be operated by separate D.C. motor and will feed at a maximum rate of 400 feet per minute. Complete control of carriage speed will be done remotely by the sawyer.

Four rooms will be devoted to the wood finishing processes. They will provide space for the mixing of various finishing materials, for application of the finishes, and for their drying and testing.

Facilities on the first floor will be provided for research and instruction in the fields of plastics and paper coating. Such rooms as a sample preparation laboratory, grinding and screening laboratory, and plastics fabrication laboratory will be provided. Other facilities will include a paper coating machine. A plastics testing laboratory and a pilot plant, which will extend through two stories of the building, will have additional features.

The second floor will house a physical and analytical chemistry laboratory, a wood chemistry laboratory, two conference and library rooms, faculty and graduate offices, a viscose preparation laboratory, a temperature control room, a cellulose laboratory, an inoculation room, and an X-ray laboratory equipped with X-ray machine and a mass spectrometer. There will also be a series of separate laboratories for research on the chemistry of wood, cellulose and polymers.

A penthouse over the shop wing will include hydrogenation and fire-testing laboratories with a roof designed for relief of explosive forces.

The main foyer of the new building will be on the third floor, which will be entered by the wooden bridge. Also on the third floor will be two classrooms, a lounge, four industrial research laboratories, a retail merchandising laboratory, and a room for specimens of wood collected throughout the world.

The fourth floor will have a recitation room, a microtechnique laboratory, two dendrology laboratories, two wood anatomy laboratories, a general wood-collection room, a photomicrography laboratory, six dark rooms, an electronic microscope and dark room, and faculty and graduate offices.

Dr. Hardy L. Shirley, Dean of the State University of New York College of Forestry, in announcing the Laboratory's early construction, stated: "The new building will enable us to expand the College's training program and its cooperative efforts with the wood industry. The faculty, alumni, and students welcome the challenge that any planning of the building's use poses."

The Screw-Holding Power of Veneered and Laminated Wood Panels*

BRUCE R. JONES

Describes experiments carried out to enlarge basic knowledge relative to differences in screw-holding power of wood in solid and laminated form.

WOOD SCREWS ARE among the most common fastening devices used in assembly of constructions employing veneer laminates. For example, most cabinets and similar items containing veneered panels are dependent for their utility partially on the strength of screw fastenings. Similarly, screws are commonly employed in the manufacture of containers, trailers and other plywood vehicles, and in home construction where various fixtures are attached to plywood panels. The screw-holding power of solid wood has been the subject of extensive investigation and considerable practical information is available regarding the strength under various conditions. Little basic theoretical information is available, however, which would apply to differences in screw-holding power of wood in solid and laminated form.

Inasmuch as the screw-holding power of laminates must be largely dependent upon the wood components, factors affecting the screw-holding capacity of solid wood can be expected to apply in part, at least, to glued wood construction. In this regard, research has revealed appreciable important information. Fairchild (3), in evaluating the strength of different sizes of screws, found that their holding power per unit of buried surface area is constant when other variables are eliminated. Cockrell (2) states that density, moisture content, grain direction relative to the longitudinal axis of the screw, growth differences, and species also have measurable effects upon the strength of screw-fastened joints. He found density to be the most important of these variables but believed it to be related to withdrawal resistance in a rectilinear manner. Later investigations (4) have shown holding power to vary directly as the square of the specific gravity of the wood when the load is applied parallel to the longitudinal axis of the screw. Cockrell (2) theorized that since moisture content has about the same effect on both screw-holding power and side hardness and since its effect on these two properties is considerably less than on other strength properties, the two must be in some way related. Brown (1), however, noted that, since screws withdrawn from side grain were clean whereas those pulled from end grain were clogged with torn-out fibers, holding power might well be related to longitudinal shear.

All of the foregoing information applied to solid wood. Few published results of experiments involving screws driven into veneerad, laminated, or plywood panels have been found. The study described herein was undertaken to determine whether or not these fabricated materials hold screws better than solid wood and, if so, to show what factors are responsible for any existing difference.

Experimental Design and Procedure

In order to avoid detailed investigation of unknowns which might later prove insignificant, a preliminary experiment was designed to examine the comparative holding power of (1) solid wood; (2) veneered lumber-core, three-ply panels in which core density, veneer thickness, and veneer grain direction with respect to the core were varied; (3) all-veneer plywood of varying veneer thicknesses, and (4) laminated wood of varying veneer thicknesses.* Fourteen different panels were prepared using the following types of construction:

Panel No.	Core Material (¾ inch in thickness)	Veneer Material	Grain Alignment
1	yellow poplar	solid	
2	yellow poplar	1/40-in. yellow birch	veneer parallel to core
3	yellow poplar	1/40-in. yellow birch	veneer perpendicular to core
4	yellow poplar	1/16-in. yellow birch	veneer parallel to core
5	yellow poplar	1/16-in. yellow birch	veneer perpendicular to core
6	yellow birch	solid	
7	yellow birch	1 40-in. yellow birch	veneer parallel to core
8	yellow birch	1 40-in. yellow birch	veneer perpendicular to core
9	yellow birch	1 16-in. yellow birch	veneer parallel to core
10	yellow birch	1 16-in. yellow birch	veneer perpendicular to core
11		1 16-in. yellow birch	all plies parallel
12		1/16-in. yellow birch	adjacent plies perpendicular
13		1 8-in. yellow birch	all plies parallel
14		1 8-in. yellow birch	adjacent plies perpendicular

* This paper is a condensation of a thesis submitted in partial fulfilment of the requirements for the degree of Master of Wood Technology, Department of Wood Technology, University of Michigan.

* In this paper, plywood refers to a wood construction in which the grain direction of adjacent veneer sheets is perpendicular and laminated wood refers to a wood construction in which the grain direction of adjacent layers is parallel.

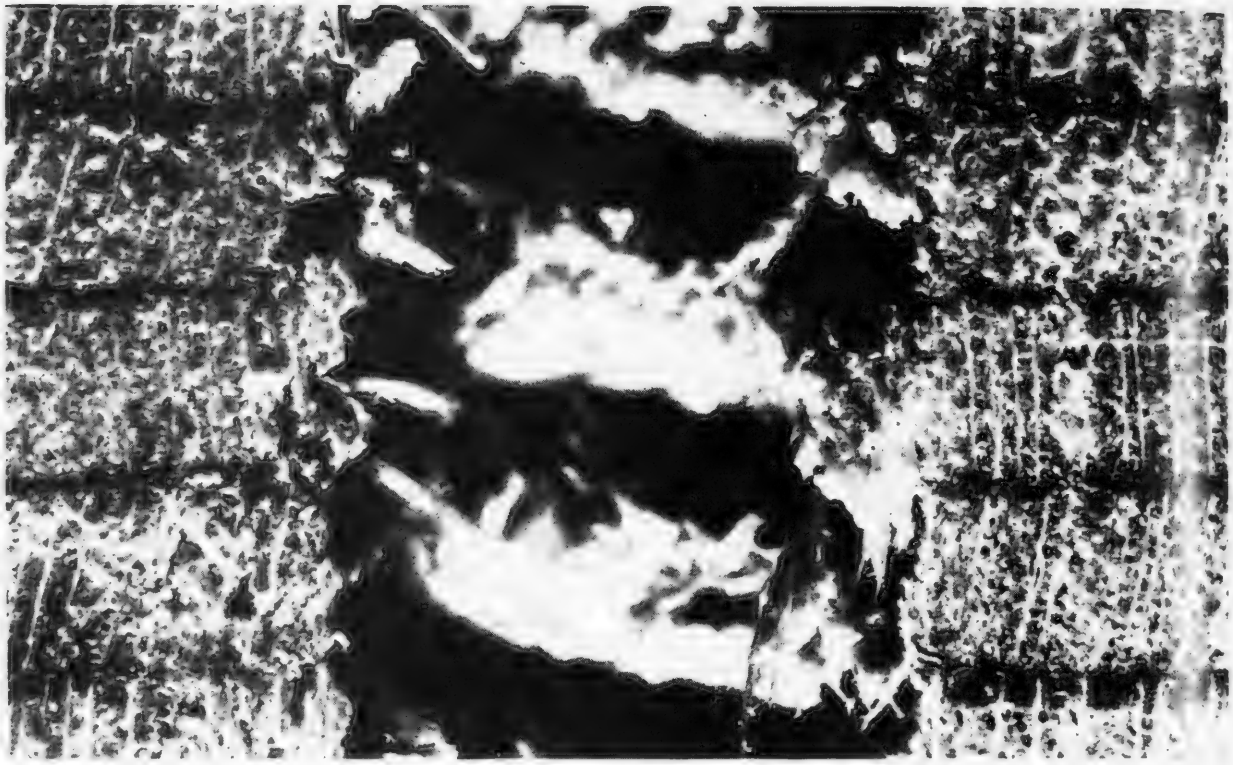

Figure 1.

Figure 2.

Ten screws were driven into each panel. Lead holes 0.9 the shank diameter of the screw were used in all panels except those with yellow poplar cores in which the lead holes were drilled 0.7 the shank diameter. Screws were pulled in a universal testing machine with the load applied parallel to their longitudinal axis. The holding power of the veneered panels was consistently higher than that of the comparable solid panels. In the all-veneer construction, panels of the thinner veneers proved to be of greater strength than those of the thicker ve-

ne..s. However, in the solid-core, thr..e-ply panels, the veneer thickness had no significant influence. A statistic analysis revealed no significant di.. rence in strength between panels in ..hich the grain direction of alternat.. plies was parallel and those in w..ch it was perpendicular. Mean valu.. for the various types of construction are tabulated below.

Table 1.

..el No.	Mean Screw-Holding Power (pounds)
1	380
2	375
3	416
4	414
5	418
6	514
7	560
8	593
9	559
10	588
11	665
12	594
13.	501
14.	563

The results of this preliminary experiment indicated that the better screw-holding ability of glued panels is a function of the glue-line properties and is independent of grain direction in adjacent plies; therefore further experimentation was designed to provide both a qualitative and a quantitative evaluation of this effect in laminated veneer panels. Two 1x6x6-inch panels, each containing ten screws, were prepared of each of four veneer thicknesses with each of three adhesives. This provided data for a replicated multiple treatment analysis of variance. The adhesives were a urea-formaldehyde resin catalyzed for both cold and hot pressing and a film-type phenol-formaldehyde adhesive. Veneer thicknesses were 1/10, 1/16, 1/20, and 1/32 inch. Species (yellow poplar *Liriodendron tulipifera* L.) screw size, moisture content, specific gravity of material, diameter of lead hole, depth of penetration, and direction of grain in alternate plies were all held constant.

During testing, when each screw reached its maximum load, the specimen was removed from the testing machine and the screw was turned out of the panel. Later, these screw holes were opened up with a band saw and a visual observation of the fibers was made. Stopping the test when the screw reached its maximum load made it possible to observe the fibers at or near their positions of maximum stress.

Results and Discussion

Panels Bonded with Cold-Press Urea-Formaldehyde Resin: It may be observed from Table 2 that a distinct improvement in strength accompanied a ..crease in veneer thickness:

Figure 3.

Table 3.—AVERAGE WITHDRAWAL RESISTANCE OF TWENTY SCREWS PULLED FROM PANELS BONDED WITH LIQUID HOT-PRESS ADHESIVE

Veneer Thickness (inch)	1/32	1/20	1/16	1/10
Average Strength (pounds)	485	433	411	401

Table 2.—AVERAGE WITHDRAWAL RESISTANCE OF TWENTY SCREWS PULLED FROM PANELS BONDED WITH COLD PRESS ADHESIVE

Ve.. r Thickness (inch)	1/32	1/20	1/16	1/10
Av.. ge Strength (pounds)	400	398	392	299

The holding power of the 1/10-inch veneer panel in which seven glue lines are engaged by the threads, is only 75 percent of that of the 1/20-inch veneer panel in which fourteen are engaged. The differences between the thinner veneer panels are not nearly as pronounced. This indicates that the increase in strength afforded by laminating is not solely the result of the presence of the bonding material. If this were true, the strength would vary inversely with the veneer thickness (or directly with the number of glue lines penetrated) in a straight-line manner. Thus, the effect of the glue line must be the result of an interaction between the adhesive and the wood material which is most pronounced between the 1/10- and 1/16-inch veneer thicknesses under these gluing conditions.

Panels Bonded with Hot-Press Urea-Formaldehyde Resin: The thin-veneer panels bonded with a hot-press adhesive (Table 3) again showed much greater strength than those of thick veneer. It is also interesting to note that in all cases, the hot-press panels were stronger than those prepared in the cold press although the same adhesive was used and was spread at the rate of 35 pounds per thousand square feet of single glue line on the hot-press panels and 55 pounds on the cold-press panels.

Most of this strength increase in the case of the hot press panels may be attributed to an increase in the specific gravity of the wood material since considerable compression occurred during the pressing operation. In order to permit valid comparison of glue-line effect between hot- and cold-press panels, these data were adjusted to remove that portion of the strength increase which resulted from specific gravity change alone. This was accomplished

Table 4.—AVERAGE ADJUSTED WITHDRAWAL RESISTANCE OF TWENTY SCREWS PULLED FROM PANELS BONDED WITH LIQUID HOT-PRESS ADHESIVE

Veneer Thickness (inch)	1/32	1/20	1/16	1/10
Average Strength (pounds)	274	381	358	323

Table 5.—AVERAGE WITHDRAWAL RESISTANCE OF TWENTY SCREWS PULLED FROM PANELS BONDED WITH FILM TYPE ADHESIVE

Veneer Thickness (inch)	1/32	1/20	1/16	1/10
Average Strength (pounds)	469	395	396	392

Table 6.—AVERAGE ADJUSTED WITHDRAWAL RESISTANCE OF TWENTY SCREWS PULLED FROM PANELS BONDED WITH FILM TYPE ADHESIVE

Veneer Thickness (inch)	1/32	1/20	1/16	1/10
Average Strength (pounds)	339	325	334	296

by dividing each of the values listed in Table 3 by the square of the ratio, $\frac{\text{Final Specific Gravity}}{\text{Original Specific Gravity}}$ The results of this adjustment are shown in Table 4. The adjusted values correspond more closely with the cold press values except in the case of the 1/32-inch veneer panels which were appreciably low. A compression of up to 10 percent of the original thickness is to be expected in all veneer panels cured in a hot press. This was true of all panels except those of 1/32-inch veneer in which a compression of 25 percent occurred. It is possible that this excessive compression damaged the fibers to such an extent that the proportionality betwen specific gravity and withdrawal resistance was altered and consequently may explain the exceptionally low adjusted value for the 1/32-inch veneer panel.

Panels Bonded with Phenol-Formaldehyde Film Adhesive: As in the case of panels bonded with the hot-press urea-adhesive, those bonded with the phenol-formaldehyde film adhesive were appreciably higher in screw-holding power than were panels bonded with the cold-press urea adhesive. Table 5 shows average values for panels bonded with the phenolic resin.

Much of the improvement in holding capacity over the cold-press panels, as was the case of hot-press urea-bonded panels, was the result of compression in the hot press. Table 6 shows the values for panels bonded with phenol formaldehyde adjusted for changes in specific gravity.

After the elimination of the influence of specific gravity increase, the trend of increasing strength with decreasing veneer thickness is less well defined here than in the case of panels bonded with the liquid adhesives. Also, the relationship of strength to veneer thickness is more nearly a straight line. This may be explained by the fact that the adhesive has limited penetration and must therefore have a more local effect than a comparable liquid adhesive.

A statistical analysis of variance showed that the withdrawal resistances of panels of different veneer thicknesses were significantly different at the 1 percent level of probability except in the case of the 1/16- and 1/20-inch panels. Analysis of the unadjusted values showed laminates bonded with all adhesives to be significantly different in screw-holding power, but the difference between the film-type phenol and the urea hot-press adhesive proved insignificant when adjusted values were substituted.

Visual Examination of Failures: Each screw had to be withdrawn about 1/16 inch before maximum load was reached. Examination of those fibers which had their long axis lying tangent to the threads indicated that they had failed in rolling shear. The area of disturbed fibers was very small, and it was evident that failure had occurred considerably before maximum load was reached. Thus, these fibers did not contribute appreciably to the holding power of the screw when it was near its maximum load. Where the ends of the fibers contacted the threads of the screw, the failure was not local. These fibers, for distances up to 3/8-inch along the grain, moved with the screw as the load was applied, similar to the bending of a short-span cantilever beam. As might be expected in a beam of this sort, the failures were in horizontal shear. This is the area from which the screw-fastened joint derives its strength. These horizontal shearing failures also provide the most obvious explanation of the low adjusted holding power of the 1/32-inch veneer hot-press panels. It is probable that planes of weakness, formed when the fiber walls were crushed by excessive compression, reduced the strength of the panel in horizontal shear to such an extent that the screw-holding power was also markedly reduced.

The gradual increase in withdrawal resistance which occurs in panels composed of progressively thinner veneers is probably the result of a reduction in the area in which slippage and eventual shearing failure can occur. The fibers in the vicinity of the glue line are strengthened by the glue. As the glue lines become closer together the unstrengthened areas become smaller and smaller.

Summary and Conclusion

The screw-holding power of panels made by gluing together sheets of veneer is greater than that of solid wood panels. This strength increase is largely the result of densification of the wood in the pressing operation and the strengthening of the wood fibers by the adhesive. That portion of the strength increase which is not the result of densification by compression is too slight to be of appreciable practical significance in view of the great variability inherent in the holding power of screws.

A screw derives most of its strength from those fibers which contact it at their ends. These fibers are bent as a beam and fail in horizontal shear. That portion of the wood in which the fibers lie tangent to the screw fails in rolling shear before the maximum load has been reached.

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Toxicity of β, β' -Oxydipropionitrile Soluble and Insoluble Fractions of Creosote and Petroleum Oils to Wood-Destroying Fungi by the Soil-Block Method[1]

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Describes means of separating petroleum and coal tar oils into two fractions, one of which is much more toxic to wood-destroying fungi than the other.

Introduction

FOR SEVERAL YEARS Battele Memorial Institute has been conducting a research project, sponsored by the Bernuth, Lembcke Company, Inc., directed toward the development of a sound procedure for the detection of the unwanted admixture of petroleum or petroleum derivatives with coal tar creosote. The results of the investigation to date have been reported in two papers[2] [3].

Following the leads developed in the fundamental exploratory investigations, the general outlines of a method were developed[3], based on the selective solvency of β, β'-oxydipropionitrile, hereafter referred to as ODPN. Saunders[4], Medcalf, Hill and Vriens[5] have shown ODPN to have unusual selective solvent properties for the extraction of aromatic compounds from hydrocarbon mixtures. This solvent is very sensitive to the presence of aliphatic side chains on aromatic nuclei in such a way that the greater the aliphatic substitution, the less soluble in ODPN is the resulting compound. In essence, the general principle of the method is to determine the distribution of an oil sample between the two essentially immiscible solvents, ODPN and low-boiling petroleum ether. Results are reported on the basis of the petroleum ether-soluble portion of the oil, hereafter called "ODPN-insoluble value". It was observed that there is a considerable difference between the range of ODPN-insoluble values of coal tar creosote oils and those of petroleum oils generally used in the wood-preserving industry. The values for 20 creosote oils ranged between 57 and 67 per cent and for 24 petroleum oils between 85 and 99 per cent ODPN-insoluble. These large differences can be used to detect the gross adulteration of creosote oils with unwanted petroleum products. Further, the detection of petroleum oils is rendered more sensitive by determining the ODPN-insoluble values for the various distillation fractions of the oils, because the distillation concentrates the petroleum product in one or more of fractions.

The work reported thus far outlines the general principles on which a satisfactory method can be developed. The optimum specific laboratory procedures and equipment have yet to be developed to a point where standardization can be recommended. Sufficient work has been done using standardized procedures to demonstrate beyond any reasonable doubt that reproducible results can be obtained. For example, results from an independent laboratory were obtained wherein the mean difference between duplicate analyses for 16 samples using a controlled uniform technique was only 0.3 per cent.

However, before proceeding with an intensive study designed to develop the most satisfactory equipment and standardized conditions for applying the principles demonstrated by the method thus far, it was deemed worthwhile to determine whether any fungicidal significance could be attached to the method, or whether this method, like most of these previously described, would be just another means of determining a chemical or physical property which has little or no relation to the wood-preserving qualities of the oil.

The purpose of this paper is to report the results of an investigation wherein the fungicidal significance of the ODPN separation was determined by the soil-block test of unweathered impregnated wood blocks.

General Approach

It was reasoned that if the ODPN separation has any fungicidal significance, the method should effectively separate any given petroleum or coal tar oil boiling in the creosote range into two fractions, one of which would be relatively more toxic to wood-destroying fungi than the other. Because the more aromatic compounds dissolve in the ODPN phase, and aromatics reputedly are more toxic than aliphatics, one can further reason that the ODPN-soluble fractions should be much more toxic than the ODPN-insoluble fractions. Four oils from widely different sources were selected for study: a straight coke oven tar creosote of domestic origin (19 CO); an English vertical retort tar creosote (6 VR); a petroleum gas-oil creosote (P-16); and a highly aromatic petroleum oil (P-2). Portions of each of these four oils were separated into two fractions, ODPN-soluble and ODPN-insoluble. Thus, 12 different samples were at hand, the four whole oils and two fractions from each of the four oils. These 12 samples were bioassayed by the soil-block technique described by Catherine G. Duncan[6] and R. H. Colley[7]. The threshold values obtained from the soil-block test for these 12 samples should demonstrate whether the ODPN separation does divide the oils into two fractions, one relatively much more toxic than the other, with the threshold value of the whole oil being intermediate; hence, whether there is fungicidal significance to the test.

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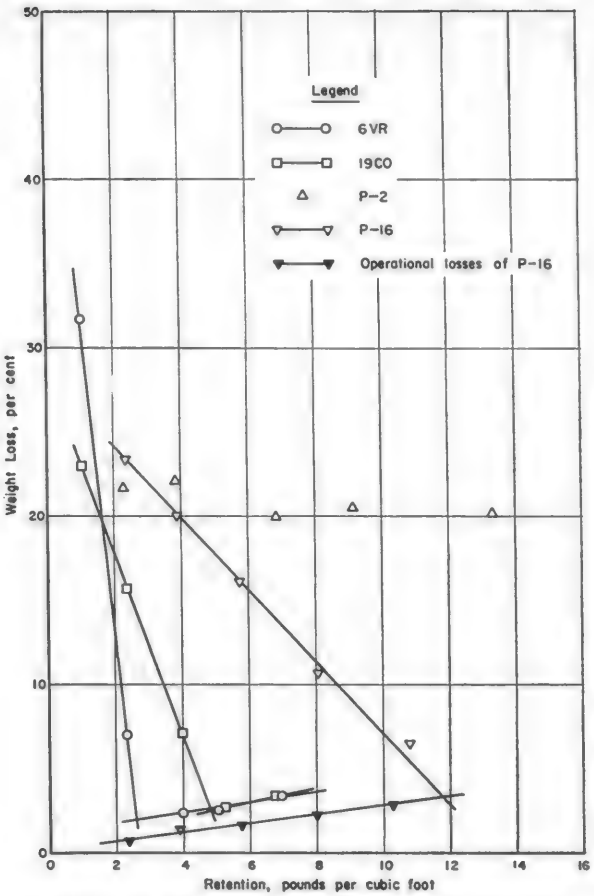

FIGURE 1. RETENTION AND WEIGHT LOSS DATA FOR 6VR, 19CO, P-16 AND P-2 WHOLE OILS

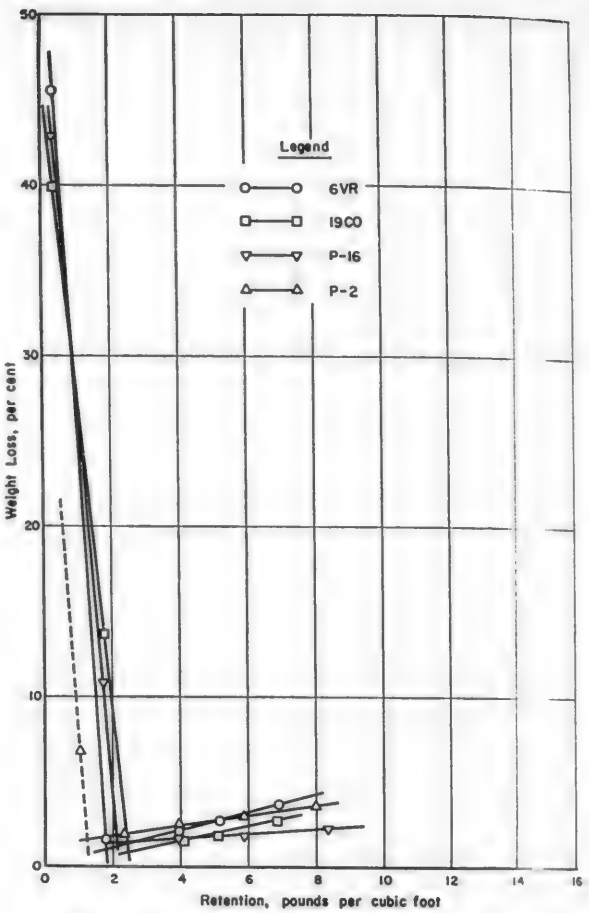

FIGURE 2. RETENTION AND WEIGHT LOSS DATA FOR ODPN-SOLUBLE FRACTIONS OF 6VR, 19CO, P-16, AND P-2

Experimental Procedure

Outline of Experimental Procedure: Samples of the four oils were separated into their respective ODPN-soluble and -insoluble fractions, which with the whole oils provided a total of 12 oil samples. Standard soil-test blocks were then impregnated with toluene solutions of these oils to provide a series of retentions for each oil. Five retention levels were chosen so as to bracket the estimated threshold value, and eight blocks were treated at each retention level. The treated blocks were conditioned for one week in a constant-temperature, constant-humidity room (78° F., 50 per cent relative humidity) to permit the evaporation of the toluene and the attainment of moisture equilibrium. The blocks were sterilized in an autoclave at 212° F., atmospheric pressure, and six blocks of each retention were placed in test bottles on feeder blocks which were supporting a luxuriant growth of test fungus, *Lentinus lepideus* (Madison 534). The remaining two blocks were placed in sterile bottles for the determination of operational losses. After incubating for 90 days (80° F., 70 per cent relative humidity), the blocks were removed from the bottles, cleaned, and replaced in the constant-temperature, constant-humidity room one week for final conditioning. The per cent weight loss was calculated from the difference in the weight of the blocks after the initial and final conditioning period.

Separation of ODPN-Soluble and ODPN-Insoluble Fractions From Oils: The ODPN-soluble and -insoluble fractions of the oils were accumulated by batchwise extraction of the whole oils. A mixture of 50 g. of oil, 400 ml. of ODPN, and 1200 ml. of petroleum ether (boiling range 30 to 60° C.), the ratio used in the ODPN test[3], was thoroughly shaken in a 2-liter separatory funnel and allowed to stand overnight. The ODPN layer was drained from the ether layer.

The ODPN-soluble fraction of the oil was recovered from the ODPN solution by refluxing and stirring a mixture of the ODPN solution, water, and n-hexane in the volume ratio of 4:20:10 for about one-half hour. Heating and stirring was stopped, and immediately upon the separation of the phases, the top (hexane) layer containing the greater portion of the ODPN-solubles was removed by siphoning. This layer was replaced by fresh hexane and the procedure repeated. Generally, three such cycles were sufficient to remove the ODPN-solubles, the third hexane extract being practically colorless. The ODPN-solubles were concentrated by boiling off the major portion of the hexane in a 250-ml. Erlenmeyer flask on a hot-plate until the temperature of the vapors in the neck of the flask reached 85° C. To remove the final traces of hexane, the flask was immersed to a depth of 2½ inches in a 75° C. water bath for four hours. The ODPN-soluble fraction of the oil was essentially free of hexane.

A similar procedure was used to remove the petroleum ether from the ODPN-insolubles. In this case the ether was boiled off until a vapor temperature of 70° C. was reached, the flask then being placed in the 75° C. water bath for four hours.

Treatment of Test Blocks and Bioassay: The test blocks* used were impregnated, sterilized, inoculated, and incubated according to the procedure given by Duncan[6]. The conditioning and incubating time, temperature, and humidity are given above. Ten untreated blocks were inoculated in order

* A detailed description of this type of test block is given in Reference 7, p. 22.

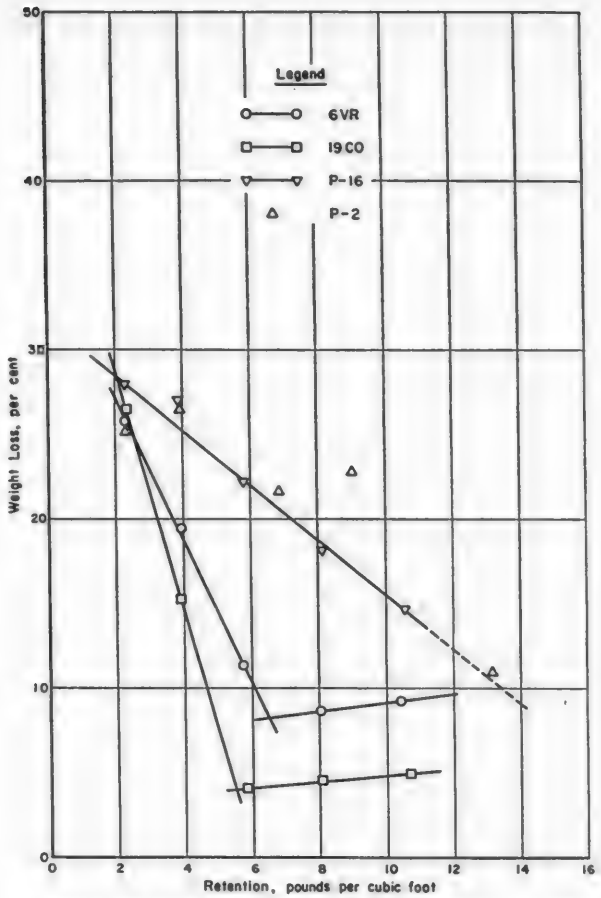

FIGURE 3. RETENTION AND WEIGHT LOSS DATA FOR ODPN-INSOLUBLE FRACTIONS OF 6VR, 19CO, P-16, AND P-2

to test the vigor of the fungus. During incubation, periodic inspections were made to determine whether or not additional water would be needed. The addition of water did not appear to be warranted during this test.

Data and Results

The AWPA distillation, specific gravity of the fractions, and ODPN-insoluble data of the four whole oils studied are given in Table 1. The average initial retention and per cent weight loss for each retention level of each sample are listed in Table 2. The weight loss vs. initial retention data were plotted in the usual manner and are shown in Figures 1, 2, and 3. Eight of these curves have a sharp inflection in the weight loss line. The retention value at which this infection occurs is called the "threshold" and represents the retention, at treatment, for a given oil that will prevent attack on unweathered blocks by the test fungus, *Lentinus lepideus*. The threshold retention values obtained are listed in Table 3. For P-16 whole oil, the intersection of the operational loss line (data given in Table 4) and the weight loss line was used to obtain the threshold retention. For the remaining three samples (P-2 whole oil, P-2 ODPN-insoluble, and P-16 ODPN-insoluble), the retentions chosen were too far below the threshold to justify extrapolation of the operational loss line and weight loss line to obtain the threshold retention.

The moisture content of the blocks at the end of the incubation period ranged between 26 and 67 per cent (based on the dry block weight), indicating that they had sufficient moisture during the incubation period to promote rapid decay.

Discussion of Results

The data in Table 3 show that the ODPN separation divides the oil, whether of coal tar or petroleum origin, into two fractions, one of which, the ODPN-soluble fraction, is much more toxic to *Lentinus lepideus* than either the whole oil or the ODPN-insoluble portion. In the cases in which a threshold could be determined, the threshold retention value for the whole oil lies between those of its two fractions.

A point of considerable interest is that the threshold retentions of the ODPN-soluble fractions are nearly the same, ranging from 1.3 to 2.5, regardless of whether the oil is of coal tar or petroleum origin. Of importance to the wood-preserving industry, however, is the fact that the quantity of the toxic fractions in oils of petroleum origin is much less than in oils of coal tar origin. The ODPN separation offers a ready means for determining the relative abundance of the highly toxic fraction in petroleum and coal tar oil mixtures.

Table 3.—THRESHOLD VALUES FOR UNWEATHERED BLOCKS

Oil	Lbs./Cu. Ft. ODPN-Soluble	ODPN-Insoluble	Whole Oil
6 VR	1.8	6.5	2.6
19 CO	2.5	5.4	4.8
P-16	2.1	>12	11.8*
P-2	1.3‡	>14	>14

*Threshold value obtained by extrapolation of decay loss line to the operational loss line.
‡Slope of decay loss line estimated.

Table 4.—OPERATIONAL LOSS DATA FOR P-16 WHOLE OIL

Retention, Lbs./Cu. Ft.	Weight Loss, Per Cent
2.37	0.7
3.90	1.4
5.75	1.7
8.01	2.4
10.27	2.9

In view of the demonstration of the presence of a highly toxic fraction in petroleum, the attitude toward the presence of petroleum admixed with creosote should be one of concern about the amount of the relatively nontoxic material present rather than about the absolute amount of petroleum present. Thus, one can reason that the addition of a petroleum having a 98 per cent ODPN-insoluble value would be more harmful than the addition of an equal amount of petroleum having an 85 per cent ODPN-insoluble value .

The ODPN-insoluble values for the whole oils correlate well with the threshold values, the higher the ODPN-insoluble value, the higher the threshold value. These data are summarized in Table 5.

Table 5.—CORRELATION OF THRESHOLD VALUES WITH ODPN-INSOLUBLE VALUES FOR WHOLE OILS

Whole Oil Sample	ODPN-Insoluble Value	Threshold Value
6 VR	55.2	2.6
19 CO	58.1	4.8
P-16	76.0	11.8
P-2	88.2	>14

Conclusions

The present work demonstrates that the selective solvent, ODPN (β, β'-oxydipropionitrile), can be used to separate petroleum and coal tar oils, boiling in the creosote range, into two fractions, one of which is much more toxic to wood-destroying fungi than

the other. The threshold values (for unweathered blocks) of the ODPN-soluble fractions are nearly the same regardless of whether the oil of of coal tar or petroleum origin. The ODPN separation thus offers a ready means of determining the relative abundance of the highly toxic fraction in petroleum and coal tar oils.

Acknowledgment

It is with great pleasure that the authors express their sincere appreciation and thanks to the Bernuth, Lembcke Company, Inc., New York City, for their financial support, which made this investigation possible, and for permission to publish the results. Special thanks and acknowledgment are also extended to Messrs. George Lumsden and Lloyd Snoke of the Bell Telephone Laboratories, and to Dr. R. H. Colley of Bernuth, Lembcke Company, and Mr. H. E. Kazmaier of Battelle Memorial Institute, for their valuable assistance in the bioassay phase of this work.

The Pressure Treatment of Western Larch Pole Sections with Pentachlorophenol Solutions*

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The relationship between penetration, over-all retention, and sapwood retention in the preservative treatment of poles is discussed prior to the presentation of results obtained in treating western larch pole sections. Both the treating results and the theoretical considerations are used as bases for recommended preservative retention and penetration requirements for this species.

Acknowledgments

The author wishes to express his appreciation to members of the J. Neils Lumber Company for obtaining the larch pole sections and for making the analyses and extractions, and to the Portland Gas and Coke Company and Big West Oil Company for supplying the preservative solutions.

Summary

WESTERN LARCH POLE sections were treated in 1953 at the Oregon Forest Products Laboratory by the Lowry process virtually to refusal with three pentachlorophenol solutions. All three solutions were found to be satisfactory for Boultonizing and treating, though emulsions did develop during final steaming and whenever solution was pulled over into the condenser. Methods for preventing pull-over and for separating oil-water emulsions are suggested.

An average over-all retention of 8.5 pounds per cubic foot was obtained in larch pole sections having an average diameter of 6.8 inches; the average sapwood retention by weighing and by extraction was 22 pounds per cubic foot. The average solid penta sapwood retention was 0.98 pounds per cubic foot. There was no significant difference in the penta content as determined by analysis and that calculated from extraction data. The preservative concentration was highest near the pole surface and decreased towards the heartwood.

Full sapwood penetration was obtained with a wide range of sapwood retentions. There was virtually no radial penetration into the heartwood.

The pole surfaces were clean at the completion of the treating cycle; no bleeding occurred during subsequent outdoor exposure. The color of the poles treated with Gasco-containing solutions changed from a very dark brown to a much lighter reddish-brown color during outdoor exposure.

A sapwood retention of 16 pounds is suggested as a desirable treatment for western larch. Over-all retentions of 4 and 6 pounds are recommended for large and small poles respectively, with a minimum sapwood penetration requirement of 0.4 inch and 90 percent. It is also recommended that any charge meeting the penetration requirement, but not the retention requirement stated above, be accepted if the sapwood contains solution retention of 16 pounds per cubic foot.

* A contributed article.

The Pressure Treatment of Western Larch Pole Sections With Pentachlorophenol Solutions

The objective in the preservative treatment of poles is to treat the more easily penetrated sapwood to a sufficient depth with a quantity of preservative that will protect the pole for extended periods of time. The depth of treatment is called penetration and the quantity of preservative is referred to as retention. These are the two basic requirements which determine the acceptance or rejection of a charge of treated material.

Retention generally is specified as pounds per cubic foot of total wood volume (hereafter referred to as over-all retention), such as a 6-, 8- or 10-pound treatment. A 6-pound treatment with a minimum penetration of ½-inch is required for western larch poles.[1] Retention also may be expressed as pounds per cubic foot of sapwood or wood penetrated. If a piece is entirely sapwood and is completely penetrated, the sapwood retention and over-all retention will be identical. As the fractional

[1] *Manual of Recommended Practices*, American Wood-Preservers' Association, Standard C

Table 1.—RETENTION OF A 5 PER CENT SOLUTION OF PENTACHLOROPHENOL AND OF PENTACHLOROPHENOL IN THE SAPWOOD OF WESTERN LARCH POLES TREATED TO AN OVERALL SOLUTION RETENTION OF 6 POUNDS PER CUBIC FOOT

Sapwood thickness* Inches	Retention of	Mid-point diameter in inches: 6	8	10	12	6
		Pounds per cubic foot of sapwood				
0.5	Solution of pentachlorophenol	19.7	25.5	31.6	1†	
	Pentachlorophenol	0.98	1.27	1.58	---	
0.7	Solution of pentachlorophenol	14.6	18.7	23.0	27.3	
	Pentachlorophenol	0.73	0.93	1.15	1.36	
1.0	Solution of pentachlorophenol	10.8	13.7	16.7	19.7	.7
	Pentachlorophenol	0.54	0.68	0.83	0.98	.28
1.2	Solution of pentachlorophenol	9.4	11.8	14.2	16.7	.7
	Pentachlorophenol	0.47	0.59	0.71	0.83	.08

*Based on measurements from 5329 western larch poles and piling contained in the 1948, 1948, 50 Proceedings of the American Wood-Preservers' Association. Avg. depth—0.7 inch. Max. depth—1.3 inches. Avg. range—0.4 to 0.9 inches.

†Insufficient sapwood. The theoretical maximum sapwood retention is about 36 pounds per cubic foot.

olume of sapwood or of treated wood
the piece decreases, the retention in
e sapwood or treated zone increases
a given over-all retention. This is
strated below and in Table 1 which
ws the sapwood retention that must
obtained in various size poles for a
ound treatment.

r-all retention cu ft	Sapwood volume Per cent	Sapwood retention Lbs/cu ft
6	100	6.0
6	60	10.0
6	30	20.0

Table 2 illustrates the theoretical
ximum retentions that can be ob-
ned in various sizes of larch poles.

Table 2.—THEORETICAL MAXIMUM OVER-ALL RETENTIONS IN WESTERN LARCH POLES

Sapwood thickness Inches	Mid-point diameter of pole in inches: 6	8	10	12	16
	Pounds per cubic foot				
0.5	11.0	8.5	6.9	5.7	4.3
0.7	14.8	11.6	9.5	8.0	6.0
1.0	20.1	15.8	13.0	11.0	8.4
1.2	23.2	18.5	15.3	13.0	10.0

*Based on a maximum retention in larch sapwood of 36.2 pounds per cubic foot at a moisture content of 10 per cent, wood specific gravity of 0.56, and density of preservative solution of 62.4 pounds per cubic foot.

A sapwood retention of 10 pounds of creosote has been suggested as a desirable treatment for poles.[2] It may be possible to obtain this sapwood retention in easily treated woods such as pine, but it may be necessary to exceed this retention to obtain the required penetration in woods such as western larch and Douglas-fir that are more difficult to treat.

With the advent of pentachlorophenol as a wood preservative, there has been an increasing tendency to specify the retention of pentachlorophenol (0.3 to 0.4 pounds) that must be obtained in the treated zone instead of a 5 percent solution in petroleum that is generally used. In the latter case sapwood solution retentions of 6 and 8 pounds are required. However, if an over-all retention of 6 pounds of the 5 percent solution is required, the sapwood retentions of solution and of penta will far exceed that needed to protect the material. The over-all retentions required for three different sapwood retentions are shown in Table 3.

A comparison of Tables 1, 2, and 3 indicates, at least, that a large proportion of western larch poles must be treated to excessive retentions to meet over-all solution retentions of 6 pounds per cubic foot. In order to obtain information on the maximum practical retention that might be expected in the sapwood, pole sections were treated by

Colley, Reginald H. *Equivalent Preservative Retention Requirements and Other Treatment Factors in the Control of Bleeding of Creosoted Poles.* South, Lembeke Co., Inc.

Table 3.—A COMPARISON OF THE OVER-ALL RETENTIONS REQUIRED IN POLES FOR SAPWOOD RETENTIONS OF 8*, 16, AND 22 POUNDS PER CUBIC FOOT

Sapwood Thickness Inches	Sapwood retention Lb/cu ft	Mid-point diameter in inches: 6	8	10	12	16
		Pounds per cubic foot of total wood volume				
0.5	8	2.4	1.9	1.5	1.3	1.0
	16	4.9	3.8	3.1	2.5	1.9
	22	6.7	5.2	4.2	3.5	2.6
0.7	8	3.3	2.6	2.1	1.8	1.3
	16	6.6	5.1	4.1	3.5	2.6
	22	9.0	7.0	5.7	4.8	3.6
1.0	8	4.4	3.5	2.9	2.4	1.9
	16	8.9	7.0	5.7	4.9	3.7
	22	12.3	9.6	7.9	6.7	5.1
1.2	8	5.1	4.1	3.4	2.9	2.2
	16	10.2	8.1	6.7	5.7	4.4
	22	14.1	11.2	9.3	7.9	6.1

*A sapwood retention of 8 pounds of a 5 per cent solution is equivalent to a sapwood retention of 0.4 pounds of pentachlorophenol.

Table 4.—DESCRIPTION OF PENTACHLOROPHENOL SOLUTIONS

		Gasco[1]	Big West[2]	
Gravity at 60° F.	API	2.6	12.2	
	Specific	1.05	0.98	
Flash Point—PM—°F.		182	212	
Viscosity—SUS in seconds	100° F.		152.5	
	210° F.	31	43.8	
Four point	° F.		55	
Analine point	° F.		112.4	
Penta by wt.	per cent	5.3	0	5.0
Color		Dark brown	Green	Nearly black
Distillation in ° F.	Barometer		24.9 in.	
	IBP	309	436	
	5 %	466	510	
	10 %	482	554	
	18.5%	500		
	20 %		608	
	30 %		650	
	40 %		680	
	50 %		700	

[1]Portland Gas and Coke Company, Portland, Oregon.
[2]Big West Oil Company, Kevin, Montana.

the Lowry process[3] virtually to refusal. Additional information also was obtained on (1) the treating characteristics of the two oils used and a mixture of these oils, and (2) the cleanliness of the final product.

Description of Equipment and Material

Equipment: All charges described in this report were treated in an experimental plant having a cylinder 12½ inches in diameter with a usable length of 10 feet. The preservative was circulated continuously during treatment through an external heater. The Rueping and PM (pressure-measuring) tanks used in commercial practice were combined into one vertical tank in the experimental plant. A charge usually consisted of two or three 5-foot pole sections.

Preservatives: The treating solutions (Table 4) consisted of a 5 percent pentachlorophenol solution supplied by the Portland Gas and Coke Company (Gasco), and a 10 percent pentachlorophenol solution supplied by the Big West Oil Company. The 10 percent solution was diluted with Big West Oil to a 5 percent solution for use.

[3] The terms Lowry and Rueping refer to the initial air pressures applied to the wood before the cylinder is filled with preservative. Rueping pressures used are higher than atmospheric, initially, while the initial pressure used in the Lowry process is atmospheric.

The Gasco oil was dark brown, had a high specific gravity (1.055 at 60 deg. F.) and was very fluid at all temperatures. The Big West Oil without penta had the greenish color of a heavy motor oil; the pentachlorophenol solution was nearly black in color. It was quite viscous at room temperature and had a specific gravity of 0.98 at 60 deg. F.

Pole Sections: The 10-foot western larch pole sections described in Table 5 were machine peeled. The sapwood, which averaged 0.7 inch in thickness, comprised about 35 percent of the total wood volume. The moisture content of the sapwood varied from 29 to well over 100 percent,* while that of the heartwood averaged 41 percent with but little variation. The heartwood of a

* On an oven-dry weight basis.

Table 5.—DESCRIPTION OF WESTERN LARCH POLE SECTIONS

	Average	Range
Diameter, inches	6.8	5.6 -9.6
Sapwood thickness, inches	0.7	0.5 -1.2
Number of rings in outer ½-inch	14	8- 25
Summerwood, per cent	40	35- 45
Moisture content, per cent		
Whole cross section	59	36- 86
Sapwood	81	29-120
Heartwood	41	34- 52
Specific Gravity		
Whole cross section OD/M[1]	0.51	0.44-0.57
OD/OD[2]	0.58	0.48-0.66
Sapwood, OD/OD	0.57	0.48-0.66
Heartwood, OD/OD	0.60	0.50-0.69

[1]Oven-dry weight and green-volume basis.
[2]Oven-dry weight and oven-dry volume basis.

Table 6.—TREATING SCHEDULES

Charge	Conditioning period: Average temp. Deg F	Conditioning period: Duration Hr:Min	Conditioning period: Vacuum Inches	Conditioning period: Duration of vac. Hr:Min	Initial air: Pressure Psi	Initial air: Duration Hr:Min	Pressure period: Average temp. Deg F	Pressure period: Duration Hr:Min	Pressure period: Max. pressure Psi	Pressure period: Time to max. pres. Hr:Min	Final vacuum: Max. vac. Inches	Final vacuum: Duration Hr:Min	Total Time Hr:Min
47	198	7:35	15 22	1:00 3:00	0	over night	205	3:30	100	2:00	23	1:25	13:35
48	200	6:40	15 22	1:00 3:40	0	0:40	200	3:35	100	1:05	22	0:30	11:40
49	196	14:05	15 25	1:25 10:05	Dropped oil under vacuum		200	7:15	105	2:00	25	1:00	25:15*
50	198	10:25	0 15 22	3:15 1:30 5:45	0	over night	200	8:05	104	2:00	24½	1:00	22:30*
52	200	16:00	0 15 22	2:00 3:00 11:00	0	1:00	200	6:00	107	2:00	25	1:00	27:00*
53	200	11:00	0 15 22–24	2:00 2:00 7:00	0	1:00	200	6:45	105	2:00	25	1:00	22:45*
54	210	17:00	15 23	1:00 14:00	0	----	200	5:30	105	2:00	25	0:30	27:00*
55	Kiln dried				0	----	200	8:50	105	2:00	25	1:00	11:50*
56	180	1:30	Kiln dried		0	----	200	8:30	103	2:00	25	1:00	14:30* †
57	207	10:30	19 20 24	2:00 5:00 1:00	0	over night	210	6:00	103	2:00	25	1:00	20:30*
58	210	12:00	22 25	9:00 3:00	0	over night	210	6:00	100	2:00	25	1:00	21:50
60	225	5:20	20	3:30	-	-	207	2:15	103	2:00	----	-	12:35
62	200	1:00	-----	-----	-	----	Pumped out under 103 psi, raised air pressure to 120 psi—pressed 1¾ hours 210	4:00	100	2:00	25	1:00	7:35

*Includes 2-hour final steaming at 235 deg F and 1-hour fina lvacuum.
**Steaming 1 hour to 275 deg F; ½-hour final vacuum.
†One-hour expansion bath (220 deg F) and one-hour vacuum.
††Additional ½-hour steaming period after steaming and vacuum.

number of poles contained concentric rings of light-colored wood resembling included included sapwood.

General Procedure and Treating Schedules

Each 10-foot pole section was given a number, and metal tags bearing the pole number and a letter A or B were nailed on each end. The pole was then cut into two 5-foot sections (A and B) and cross-sections were removed for moisture content and specific gravity determinations. The pole sections were weighed and stored outdoors until used.

The pole sections were weighed immediately prior to treatment and after each treatment phase. Generally, the poles were Boultonized to a calculated average sapwood moisture content of 25 percent. One-quart oil samples were removed at the strainer after Boultonizing and after the pressure period while the oil was being circulated.

Both the solutions and borings from the treated pole sections were analyzed for pentachlorophenol content. Borings were also extracted for oil content.

Moisture Content, Specific Gravity and Other Characteristics of the Wood: Two one-inch cross sections were cut from the center of each 10-foot pole. One section was cut to separate the sapwood and heartwood. The whole section, heartwood section and sapwood rings were then weighed separately, immersed in water to obtain their volumes, and oven dried. They were again immersed in water after oven drying. Specific gravity values were calculated for all sections on both green volume and oven-dry volume basis.

The annual growth of rings in the outer half-inch of the sapwood were counted and the percentage of summer wood in these rings was estimated.

Analysis and Extractions: The Western Electric procedure (KS-4629, Section 2.17) was followed for the determination of pentachlorophenol in the solution and in the borings. Oil extractions were made by the toluene method; baskets containing the treated material were suspended in 500 ml wide-mouth flasks beneath the return from the water trap.

Pentachlorophenol analyses were made on increment borings, and oil extractions were made on cuttings from a 7/8-inch wood drill. The first determinations were made on borings and cuttings taken at different points, with only that portion from 0.1 to 0.6 inch from the surface being used. This later was changed so that 6 increment borings were taken from each 5-foot pole section and the sapwood depth was measured and recorded for each boring. The sapwood portion was analyzed for pentachlorophenol. Seven-eighth-inch extraction borings were then taken around each of the increment boring holes to the measured sapwood depth. Later, analyses and extractions were made on each ¼-inch of sapwood.

Treating Schedules: The treating schedules employed (Table 6) were similar to those used commercially by the J. Neils Lumber Company for treating western larch with creosote solutions. Most of the treatments were continued to refusal as defined in Paragraph 3.1, Standard M2-52, American Wood-Preservers' Association Manual of Recommended Practices. The Lowry process was used for all charges except No. 49 which was treated by a full-cell process. Charges 55 and 56 were kiln dried prior to treatment.

Table 7.—SUMMARY OF RETENTION DATA FROM WEIGHINGS

Charge	Solution retention: Water removed during Boultonizing	Solution retention: Solution recovery: During Boultonizing	Solution retention: Solution recovery: During Pressure period	Solution retention: Solution recovery: Vacuum period	Solution retention: Solution recovery: Steam and vacuum	Solution retention: Solution recovery: Total	Solution retention: Gross	Solution retention: Net	Sapwood retention Lb/cu ft	Fraction of void filled
	Pounds per cubic foot of wood									
48	5.3	2.1	4.7	...	...	...	6.8	...	19.9	0.55
49	10.6	...	11.9	0.9	0.7	1.6	11.9	10.3	24.5	.65
50	9.4	...	10.8	1.4	1.2	2.6	10.8	8.2	19.2	.51
52	4.5	5.7	6.1	2.1	0.9	3.0	11.8	8.8	19.9	.57
53	3.6	...	11.2	1.4	0.7	2.1	11.2	9.1	20.7	.59
54	7.8	4.4	5.5	0.7	0.3	1.0	9.9	8.9	26.7	.71
55	Kiln dried		9.5	1.2	0.7	1.9	9.5	7.6	22.8	.63
56	Kiln dried		8.0	0.7	0.7	...	8.0	7.3	27.6	.81
57	5.7	4.8	8.4	1.5	1.2	2.7	13.2	10.5	22.8	.68
58	4.0	3.7	8.7	1.7	0.9	2.6	12.4	9.8	24.0	.74
60	0.8	2.0	7.8	...	...	...	9.8	...	35.8	.98
62*	Air dry		7.9	2.5	0.9	3.4	7.9	4.5	14.5	.41
Total	51.7	22.7	100.5	14.1	8.2	20.9	121.1	85.0	278.5	
Average	5.7	3.8	8.4	1.4	0.8	2.3	10.1	8.5	23.5	.65
Average of 49–55	...	...	...	...	...	...	...	8.8	...	...

*End-coated.

Treating Results

Retention of Solution: The average over-all solution retention by weight-

Table 8.—SUMMARY OF RETENTION DATA FROM EXTRACTIONS AND ANALYSES

Charge	Zone used Inches	Sapwood depth Inches	Penetration Inches	Fraction of volume treated	Solution retention		Penta retention				Fraction of void filled†	Penta content of solution Per cent
					Wood extracted	Total wood	Wood analyzed (A)	Total wood*	Wood extracted* (E)	Ratio A/E		
					Pounds per cubic foot							
49	0.1–.60	0.7	0.7	0.420	26.70	10.9	1.46	0.60	1.220	1.20	0.71	4.58
50	.1–.60	0.7	0.7	.426	24.28	10.4	0.985	0.42	1.083	0.915	0.64	4.46
52	0–.74	0.74	0.76	.442	20.08	7.7	0.831	0.33	0.849	0.960	0.57	4.43
53	0–.73	0.67	0.73	.350	22.76	6.8	0.896	0.26	1.008	0.836	0.65	4.43
54	0–.69	0.69	0.69	.290	18.32	5.3	0.870	0.25	0.824	1.053	0.49	4.50
55	0–.59	0.62	0.59	.300	21.03	6.1	0.808	0.23	0.946	0.857	0.59	4.50
Aver				.371	22.19	7.9	0.975	0.35	0.991	0.970	0.61	

alculated.
apwood moisture content assumed to be 20 per cent.

ing for all charges (Table 7) was 8.5 pounds. The amount retained by the wood or recovered during the various treatment phases was as follows:

Boultonizing	3.8 pounds retained
Pressing	8.4 pounds retained
Final vacuum	1.4 pounds recovered
Final steaming and vacuum	0.8 pounds recovered

Boultonizing removed 5.7 pounds of water per cubic foot of wood.

In six of the charges on which oil extractions were made, the average over-all retention was 7.9 pounds by extraction and 8.8 pounds by weighing (Tables 7 and 8). The average sapwood retention was 22 pounds by extraction and 23 pounds by weighing. The apparent discrepancy in sapwood retention by these two methods is due to the variation in sapwood thickness as determined for each method. Sapwood retentions determined by extraction ranged from 8.2 to 32.3 pounds per cubic foot.

Retention of Pentachlorophenol: The average retention of pentachlorophenol by analysis (Table 8) was 0.975 pounds (over-all retention of 0.35 pounds), while that calculated from oil-extraction data was 0.991 pounds. The application of Student's "t" test to the individual extraction and analysis data indicated that there was no significant difference between the results of the two methods (5 percent significance level and 46 degrees of freedom).

The retention of pentachlorophenol was highest near the surface and decreased with depth (Table 9). The average pentachlorophenol content of the outer, second, and third 0.25-inch interval was 1.065, 0.743, and 0.619 pounds per cubic foot, respectively.

Penetration: Complete sapwood penetration was obtained in pole sections having sapwood thicknesses of from 0.5 to 1.05 inches, with sapwood retentions in individual sections of from 8 to 34 pounds (no individual datum is included). Although all of the borings had full sapwood penetration, a few of the sections were found to contain small areas of untreated sapwood when they were cut lengthwise and surfaced. Penetration appeared to extend slightly into the heartwood in some pieces, although usually for not more than 0.1 inch. Ringed penetration (summerwood treatment only) was observed in a few instances, but was confined to a portion of a pole section.

Table 9.—PENTACHLOROPHENOL CONTENT OF LARCH SAPWOOD AT VARIOUS DEPTHS*

(Pentachlorophenol content of solution 4.5 per cent)

Charge	Pole section	Solution retention		Pentachlorophenol retention in nearest ¼-inch increments			
		Sapwood**	Total wood	Outer	Second	Third	Average
		Lb. soln. per cu ft wood		Lb pentachlorophenol per cu ft wood			
54	19A	17.80	5.0	1.135	0.559	-----	0.799
	20A	18.85	5.6	1.046	0.974	0.821	0.942
55	21A	18.10	7.3	1.096	0.669	0.417	0.715
	22A	23.96	4.9	0.985	0.772	-----	0.902
Average		19.68	5.7	1.065	0.743	0.619	0.839

*Six borings extracted for each sample.
**By extraction.

Cleanliness and Color: All of the pole sections treated with Gasco solution or with Gasco plus Big West solution were very dark in color. After being stored outdoors during the summer and fall months the color changed to a reddish brown. The poles treated with Big West solution were quite dark immediately after treatment, but gradually lightened in color to a dull grayish green.

With the exception of charge 60, all poles were clean and quite dry. The oily surface condition of charge 60 was attributed to the experimental treating schedule employed; a second steaming cleaned them considerably.

There was no bleeding of the sections stored outdoors, although the surfaces were slightly oily during hot weather.

Characteristics of the Treating Solution: The Gasco solution was very fluid at all temperatures and was pumped readily. The Big West Oil, although difficult to pump at room temperature, was pumped readily at elevated temperatures.

No trouble was encountered during Boultonizing unless solution was pulled over into the hotwells. This recurred several times when the vacuum was applied directly to the retort, and resulted in the formation of an emulsion that was difficult to separate. No solution was pulled over when the vacuum was applied to the top of the combined PM-Rueping tank. A considerable quantity of light ends collected in the hotwells when the Gasco solution was used. Only a very small amount of light ends were pulled over with the Big West Oil.

Both pentachlorophenol solutions darkened appreciably with use. There was a change in pentachlorophenol content of the Gasco solution with use (Table 8) which cannot be explained satisfactorily. Dilution with Gasco oil (no penta) may have occurred; although, had this happened, the dilution probably would have been much greater than that shown by the penta analyses.

Final steaming resulted in the formation of a heavy emulsion in the retort with all solutions used.

Discussion of Results

Retention of Solution:[4] The sapwood retention of 22 pounds obtained by the Lowry process probably represents the average maximum that can be obtained in practice. This retention undoubtedly exceeds that required to protect the pole during service, and is considerably higher than could be expected in material treated by the Rueping process. In view of the fact that all of the larch sections received full sapwood treatment, it would appear entirely feasible to treat this species with lower solution retentions than now are required.

The retentions (based on total wood volume) required for sapwood retentions of 8, 16, and 22 pounds per cubic foot were compared in Table 3. These figures and the treating results indicate that a treatment aimed at a sapwood retention of 16 pounds would be desirable from both the standpoint of the user and the treating plant. The selec-

[4] It is the opinion of the author that the over-all solution retentions recommended in this section can be employed also for coal-tar creosote.

tion of this 16-pound sapwood treatment is, admittedly, arbitrary, yet it appears to be one that would insure full sapwood penetration without an excessive retention of solution.

This 16-pound sapwood retention probably could be met with over-all retention of 4 and 6 pounds for Group B[5] (larger) and Group A (smaller) poles, respectively. These over-all retentions combined with a minimum sapwood penetration requirement of 0.4-inch and 90 percent, should provide for the better utilization of western larch poles with greater assurance to the user of a better-treated and cleaner product. However, such a specification should include a provision for permitting the acceptance of a charge that does not meet the over-all retention requirement, if it meets the penetration requirement and the sapwood retention is at least 16 pounds as determined by extraction.

Retention of Pentachlorophenol: The high sapwood solution retentions required to meet an over-all 6-pound retention result in correspondingly high pentachlorophenol retentions. In the case of most large poles and all thin sapwood poles, the sapwood retentions must exceed the 22-pound retention obtained in this study. Although the 16-pound sapwood retention would reduce the amount of pentachlorophenol from 1 pound to 0.8 pound, this lower concentration still appears to be higher than necessary. This pentachlorophenol concentration could be lowered by reducing the pentachlorophenol content of the solution, but it would be more desirable to further reduce the amount of 5 percent solution pressed into the wood. The uniformly thin sapwood of western larch should make it possible to obtain full sapwood penetration with over-all retentions of less than 4 pounds.

Penetration: Less erratic penetration would be expected in the experimental treating plant because of the more uniform treating conditions within the cylinder and uniform size of the pole sections. Obtaining uniformly deep penetration in practice, particularly with reduced retentions, will require greater attention to the seasoning and conditioning of the material, and may require somewhat longer pressing periods at lower pressures if the Lowry process is used.

Cleanliness and Color: The clean treatments that were obtained, and the lack of bleeding during the summer months, speak well for the Lowry process. In many instances, the sapwood retentions were very high, which would be conducive to bleeding. The change in color of the pole sections treated with Gasco oil (or a mixture of Gasco and Big West Oil) from a very dark to a light brown may have had much to do with the lack of bleeding.

How these same sections would have reacted under more severe summer conditions is a matter for conjecture.

Characteristics of the Treating Solutions: Emulsions appeared to form whenever the oil came in direct contact with either water or steam. It is very likely that the emulsion developed when water condensed in the presence of oil, such as would have occurred in the condenser during Boultonizing and when solution was present in the retort during the final steaming period. The development of an emulsion during steaming probably cannot be prevented, but it should be possible to eliminate that formed as a result of pullover during Boultonizing.

The experimental plant had a thermocouple in the vapor line from the combined PM-Rueping tank. The temperature at this point has been found to be an effective guide for increasing the vacuum in order to maintain a continuous flow of vapors to the condenser. The normal temperature for water vapor at a given vacuum indicates the proper flow. If the temperature decreases, the vacuum is increased slowly until the temperature corresponding to that vacuum remains constant. Increases in temperature above normal indicate that solution is beginning to be pulled over and that the vacuum should be reduced.

The emulsion formed in the hot wells could not be separated by gravity, but when allowed to flow onto a wire screen (30 to 100 mesh) the oil passed through the screen while the water collected on top and ran off at a different point. So long as the screen was wet with oil no water ran through. It appears that this screening principle based on surface tension of the liquids might be applied to separators for more efficient operation.

[5] These groups are defined in Standard C4, *Manual of Recommended Practices*, American Wood-Preservers' Association. Group A—poles whose 6-foot-from-butt circumference is less than 37.5 inches. Group B—37.5 inches or greater.

Conclusions

1. Treatment specifications based on an over-all retention of 6 pounds per cubic foot result in excessive solution and pentachlorophenol concentration in the sapwood of a large proportion of western larch poles.

2. The maximum practicable sapwood retention that can be expected in western larch is about 22 pounds per cubic foot.

3. Complete sapwood penetration in western larch poles can be expected with a wide range of sapwood retentions.

4. There is virtually no penetration in the heartwood of western larch poles.

5. A clean treatment can be obtained with high sapwood retentions when the Lowry process is employed.

6. All three solutions were found to be satisfactory for Boultonizing and treating larch poles.

7. Emulsions can be expected to form during the final steaming period, and when solution is pulled over into the condenser during Boultonizing.

8. Poles treated with Big West oil were the lighter in color immediately after treatment. Solutions containing Gasco oil produced darker colored poles; however, the color of the pole surface changed to a reddish brown when placed outdoors over summer.

Recommendations

1. A sapwood retention of 16 pounds per cubic foot is suggested as a desirable treatment for western larch poles. Over-all retentions of 6 and 4 pounds are recommended for small poles (AWPA Group A) and for large poles (AWPA Group B), respectively.

2. A minimum sapwood penetration requirement of 0.4 inch and 90 percent should provide for the better utilization of larch poles with full assurance to the user of a satisfactory product.

3. Any charge meeting the above penetration requirement, but not meeting the over-all retention requirements, should be considered acceptable if the sapwood retention averages 16 pounds of solution as determined by extraction.

4. Additional investigations should be undertaken to determine the minimum sapwood retentions that are necessary to obtain complete sapwood penetration.

Tests of Some Superficial Treatments of Exposed Wood Surfaces for their Protection Against Fungus Attack

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Describes tests made to determine effectiveness if preservatives, sealers and water repellents, and combinations thereof, in protecting exposed wood surfaces against fungus attack.

DURING WORLD WAR II the problem arose of protecting interior wing parts of wood aircraft against decay. The hazard of decay was occasioned by a certain amount of unavoidable wetting of these parts in the course of normal operations, and by rain leakage through damaged skins of wings stored in the open awaiting repairs. As conventional preservative treatment of the wood prior to installation was not permissible, protective measures had to be some form of surface treatment after the wings were constructed. Attention at the Forest Products Laboratory was directed, therefore, to an exploration of the fungus resistance provided by relatively superficial treatment of the wood, such as by spraying, brushing, or flowing. Interest centered more on the relative effectiveness of different basic kinds of treatment than on the specific products that might be used. Some of the main questions, for example, were as to the decay-inhibiting merits of a preservative alone, or of a sealer alone; of a mixture of a preservative and a water repellent or of a preservative and a sealer; and of double treatments, such as two applications of a sealer or a preservative treatment followed by an application of a sealer or of a sealer incorporating a preservative.[2]

Findings were not published because the information was restricted at the time and the work was broken off with the end of the war. Now that restrictions have been removed, however, it seems desirable to report that portion of the data that is generally applicable to wood surfaces in a variety of situations above ground.

[1] Maintained at Madison, Wis., in cooperation with the University of Wisconsin.

[2] Definitions of the terms "sealer," "water repellent," "preservative sealer," and "water repellent preservative" may be found in appendix I of Forest Products Laboratory Report R1495.

Test Procedure

The decay-inhibiting potency of the different treatments was evaluated in the laboratory by use of controlled test methods conducive to rapid and severe fungus attack.

The test material consisted of 1/4- by 1- by 3-inch slabs of Sitka spruce heartwood and 3/16- by 1- by 3-inch slabs of sweetgum sapwood in the form of plywood (1/16-inch plies) bonded with a waterproof glue. To make the applications of sealers as uniform in depth as possible, the edges and corners of the slabs were rounded by sanding prior to treating. Both Sitka spruce and sweetgum are low in natural resistance to decay, hence differences in amounts of decay occurring in either of them can be ascribed mainly to variations in the fungus resistance provided by the surface treatment of the wood.

Basic treating materials were 2 preservatives, 2 sealers, and 1 water-repellent preparation, as follows:

Preservative 1 — Pentachlorophenol, 2 percent + chloro- 2-phenylphenol, 3 percent in mineral spirits.

Preservative 2—Pentachlorophenol, 5 percent in mineral spirits.

Sealer 2—Paraphenyl phenol-formaldehyde resin varnish of 12½ gallon length (50-50 linseed and tung oil) reduced to 30 percent nonvolatile in aromatic and aliphatic thinners.

Sealer 3—Ester gum varnish of 12½ gallon length (linseed oil) reduced to 30 percent nonvolatile in aliphatic thinner.

Water repellent 2—Hercolyn (methyldihydroabietate), 7.5 percent; paraffin wax, 7.5 percent; pine oil, 7 percent in mineral spirits.[3]

Where a preservative was applied in a sealer or in the water repellent, 5 percent of the dry chemical was used, replacing 5 percent of the volatile solvent in the sealer or water-repellent solution.

All but the sealers were applied by dipping the air-dry slabs for 10 seconds in the respective solutions. The sealers also were applied by dipping, but with the aid of a mechanical lifting apparatus that removed the slab from the solutions at rates slow enough to provide complete drainage before removal from the solution. In treating and subsequent drying, the slabs were handled by a pin stuck in one end. In the cases of double treatments, the second treatment was made about 24 hours after the first. The slabs were placed in test usually about 6 weeks after treatment.

The decay tests were carried on in two ways. In one, the slabs were subjected to an unknown variety of decay fungi by burying them in garden soil contained in a large box in the laboratory. Water was added to the soil as needed to keep it moist but not wet. In the other, the slabs were laid on similar but untreated slabs already undergoing decay by pure cultures of a decay fungus. To retard drying in this test, the pairs of slabs were stored in a room with the relative humidity maintained in excess of 95 percent. The gum specimens were subjected to decay by *Polyporus versicolor*, one of the most vigorous and prevalent of the white-

[3] A water repellent with this high wax constituency is now recognized as likely to interfere with the drying of paint or varnish applied after it. It had no noticeable adverse effect on the final condition of the sealer coatings in the present tests. Similar results were obtained in supplementary tests with a repellent containing 3 percent wax. Commercial water-repellent preservatives, which have now been in use for many years, contain no more than 3 percent of wax, usually less.

Table 1.—RESULTS OF DECAY TESTS ON THE SURFACE-TREATED SLABS

Treatment	Treatment code	Number of trials[1]	Percent of initial weight remaining after test: Sweetgum Test A[2]	Sweetgum Test B[3]	Spruce Test A[2]	Spruce Test B[3]	Average Tests A[2]	Average Tests B[3]	Protection rating[4]
None (controls)	C	3–5	53	68	65	46	59	57	--
Sealer only	S	3–5	60	--	91	--	75	--	D
Two coats of sealer	S+S	6–10	57	69	88	62	72	65	D
Preservative only	P	6–10	71	90	82	78	81	84	C
Preservative followed by sealer	P+S	12–20	69	90	86	88	77	89	C
Water repellent + preservative, mixed	RP	12–20	86	--	95	--	90	--	B
Repellent preservative followed by sealer	RP+S	12–20	82	--	95	--	88	--	B
Preservative in sealer	PS	6–10	82	--	99	--	90	--	B
Preservative followed by preservative sealer	P+PS	3–5	99	98	100	100	99	99	A
Repellent preservative followed by preservative sealer	RP+PS	6–10	91	--	97	--	94	--	A

[1]Figures shown for sweetgum are average results of 3, 6, or 12 trials; those for spruce are average results of 5, 10, or 20 trials. Where the number of trials was 6 or 10, 2 preservatives, or 2 sealers were tested. Where the number was 12 or 20, both 2 preservatives and 2 sealers were tested.
[2]Test was made by burying the slabs in soil for 4 months.
[3]Test was made by exposing the slabs to pure cultures of a test fungus for 4 months.
[4]Arbitrary rating according to indicated relative levels of effectiveness.

rot fungi that attack hardwoods, and the spruce specimens were subjected to *Poria monticola,* one of the most prevalent and destructive of the brown-rot fungi occurring in softwoods. The period of exposure in both forms of test was 4 months. This period and the conditions of both forms of exposure provided a severe test of the treating systems.

Observations

Decay was measured by the percentage loss in dry weight of wood in the respective slabs. However, as the percentage of initial slab weight remaining after testing denotes directly rather than inversely the relative degree of protection afforded by a given treatment, the results, presented in table 1, are given in terms of retained weight (i.e., 100 minus percent loss).

The table contains average results obtained with preservatives 1 and 2, and with sealers 2 and 3. It is unnecessary to consider these materials separately, since the data for all point to essentially the same conclusions with respect to the relative merits of the different types of treatment. Preservative 2 was somewhat superior to preservative 1 in general level of effectiveness, and sealers 2 and 3 were practically equal in effectiveness.

The percentage weight retentions listed in table 1 show that the different kinds of surface treatment varied markedly in their capacity to protect the underlying wood against decay. The protection ratings in the last column may aid in making comparisons. The most significant observations and some conclusions that might be drawn from them are:

1. The tests were severe, as indicated by the average retentions of less than 60 percent of the original amounts of wood in the untreated control slabs.

2. A plain sealer, whether applied by itself (S) or after preservative treatment (P + S or RP + S), generally imparted comparatively little decay resistance. Moreover, where used alone, it was no more effective in a double coating (S + S) than in a single coating (S).

3. A combination of water repellent and preservative (RP) gave a large amount of protection against decay. It was substantially more effective than a preservative alone (P). This is attributed to a partial binding of the preservative by the water-repellent chemicals, thereby reducing losses of preservative through volatilization. Losses of even slightly volatile chemicals tend to build up to significant amounts where the depth of treatment is comparatively shallow. In this connection it may be noted further that the binding effect of the water-repellent chemicals apparently was more influential than the blanketing effect of a sealer in maintaining fungus-inhibiting quantities of chemical on the wood.

4. The sealers were markedly improved as fungus barriers by incorporating a preservative in them (PS). The effectiveness of this combination was comparable to that of the water-repellent preservative (RP).

5. Maximum protection against decay was given by double treatments with a preservative or a water-repellent preservative followed by a preservative sealer (i.e., P + PS or RP + PS). The combination P + PS almost completely prevented decay. It was somewhat more effective than RP + PS, but the reason for this is not clear in view of the superiority of RP over P (observation 3).

Discussion and Conclusions

The indicated relative merits of the different kinds of treatment relate to protection against infection by wood molds and blue-stain fungi as well as by decay fungi. Thus a treatment indicated to be most effective against decay also would have most promise for controlling molding and staining of wood. Although decay presumably would be of major concern generally, there is interest in stain and mold control for such items as house siding that is to be maintained with a natural appear...

In assessing the practical implications of the observations, it should be kept in mind that the testing brought to bear only a part of the environmental conditions to which wood surfaces may be subjected in service. Perhaps the chief limitation was the exposure of the material to continuous dampness. Sealers and water repellents are least effective in minimizing changes in moisture content when exposed to continuous dampness; they become much more effective when the exposure is to alternate wetting and drying at short intervals, such as in exposure to the weather. On the other hand, exposure to sunlight and weather may destroy sealers and water repellents much more rapidly than does indoor exposure to dampness alone.

Nevertheless, certain conclusions about superficial treating seem warranted with respect to most conditions of exposure. Where maximum protection of exposed surfaces against decay, blue stain, or mold is desired, reliance should not be placed on a sealer alone nor on a preservative alone; both should be used. Moreover, a good preservative should be incorporated in the sealer, and the preservative solution should contain effective water-repellent ingredients. The cost of such additions is negligible compared with other costs of treating, and therefore is easily justified by the sizeable added protection. The use of a water-repellent preservative rather than plain preservative in advance of the preservative sealer may be favored despite the lack of supporting test evidence. This seems reasonable because of the demonstrated marked superiority of the mixture alone over the preservative alone, and because it is uncertain that, when weathered, the preservative sealer would maintain the share of protection that it gave in these tests.

Sticker Stain and Board Color In One-Inch Red Alder Lumber[1]

B. G. ANDERSON and R. G. FRASHOUR
Oregon Forest Products Laboratory, Corvallis, Oregon

Describes tests to determine possibility of fixing the color of red alder lumber by a steam treatment before air-drying, and also to eliminate sticker stain and poor color.

Introduction

THE OREGON Forest Products Laboratory was requested in July 1953 by the Oregon Alder and Maple Company, Willamina, Oregon to study on the problem of dark stain which developed at sticker crossings in air-drying red alder (*Alnus rubra,* Bong.) during the summer months.

Previous experience at the Oregon Alder and Maple Company had demonstrated that a uniform light-brown shade preferred by furniture manufacturers could be obtained by kiln-drying the lumber immediately after sawing, using a high initial humidity and an initial dry-bulb temperature ranging from 130 to 150 degrees F. It was observed that the color of the lumber when kiln-dried from the green condition could be varied from nearly white to chococate brown by manipulation of the relative humidity and dry-bulb temperature during the first hours (approximately 48) in the kiln. Lumber handled in this manner did not develop sticker stain. This suggested the possibility of fixing the color of the lumber by a steaming treatment before air-drying and also eliminating sticker stain and poor color. Favorable air-drying weather could then be used to full advantage, with the possibility of saving from 2 to 4 days time in the final kiln drying.

[1] A contributed article.

Four charges of freshly sawed one-inch alder lumber were steamed under various conditions and then air-dried. A fifth charge was air-dried without previous steaming.

Steaming and Drying Procedure

Five charges of approximately 200 fbm each of random-width, rough green one-inch red alder lumber were dried, surfaced, and inspected to determine the effects of the experimental initial treatment on the occurrence of sticker stain in the finished lumber. The type of treatment given to each of the five charges is indicated, Table 1.

After kiln drying, charges 1, 2 and 3 were taken to the Oregon Alder and Maple Company for planing and inspection. All 3 charges were surfaced to a thickness of 15/16 inches. All boards in these three charges were found to be free from sticker stain.

The more general characteristics of the five charges after final kiln-drying are summarized, Table 2.

Boards in charge 1 were colored to a uniform light-brown color with no mottling. The shade of color in charge 1 was said to conform to the preference of California furniture manufacturers.

Boards in charge 2 were colored to a uniform light-brown color of lighter shade than that in charge 1. The shade of color in charge 2 was said to fit the term "lifeless" or "without luster", as described by Floyd Edmiston, of the Oregon Alder and Maple Company. Boards with a shade of color found in charge 2 are said to be undesirable from the furniture manufacturers' standpoint. The difference in color shade or luster between charges 1 and 2 was attributed to the difference in initial steaming temperature.

Boards in charge 3 were free from sticker stain, but contained irregular areas stained in a mottled pattern. The background color in these boards was

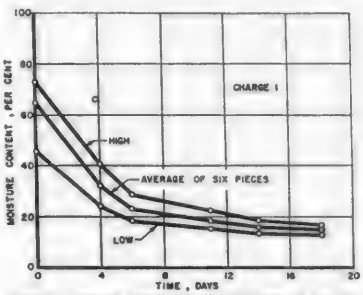


FIGURE 1. MOISTURE CONTENT DURING AIR-DRYING OF ONE-INCH RED ALDER LUMBER AFTER STEAMING AT 140-136 DEGREES F FOR 18 HOURS; JULY 6 TO AUGUST 3, 1953.

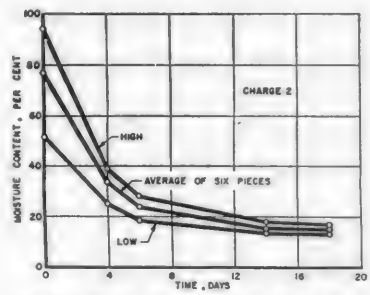


FIGURE 2. MOISTURE CONTENT DURING AIR-DRYING OF ONE-INCH RED ALDER LUMBER AFTER STEAMING AT 180-177 DEGREES F FOR 18 HOURS; JULY 16 TO AUGUST 3, 1953.

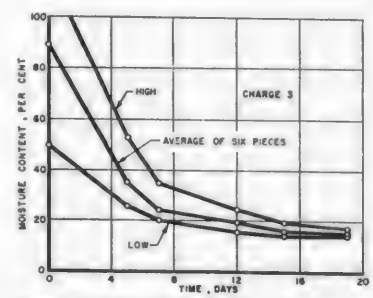


FIGURE 3. MOISTURE CONTENT DURING AIR-DRYING OF ONE-INCH RED ALDER LUMBER NOT STEAMED BUT STACKED ON HOLLOW-BACK STICKERS FROM JULY 15 TO AUGUST 3, 1953

Table 1.

Charge	Steaming treatment DB[1] Deg F	WB[2] Deg F	Time Hr	Final avg MC %	Air-drying Dates	Type of sticker	Final avg MC %	Kiln-drying DB Deg F	WB Deg F	Time Hr	Final avg MC %
1	140	136	18	65	7/16–8/3	Solid	15	180	145	31	8.7
2	180	177	18	77	7/16–8/3	Solid	14	180	145	31	8.0
3	Not steamed			89	7/15–8/3	Hollowback	15	180	145	31	8.9
4	130	130	24	94	8/7–10/12	Solid	16	180	145	120	4.7
5	120	120	24	86	8/7–10/12	Solid	18	180	145	120	5.0

[1] Dry bulb.
[2] Wet bulb.

Table 2.

Charge	Color	Pattern	Sticker stain	Remarks
1	Light-brown	Uniform	None	Desirable color
2	Flat light-brown	Uniform	None	Lusterless; undesirable
3	White to pink	Mottled	None	Undesirable color
4	Similar to charge 3	Somewhat mottled	None	Undesirable color
5	Lighter than charge 4	Slightly mottled	In 18% of boards	Undesirable color

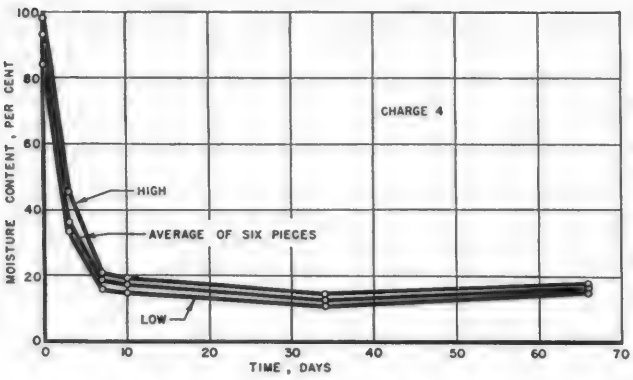


FIGURE 4. MOISTURE CONTENT DURING AIR-DRYING OF ONE-INCH RED ALDER LUMBER AFTER STEAMING AT 130-130 DEGREES F FOR 24 HOURS; AUGUST 7 TO OCTOBER 12, 1953.

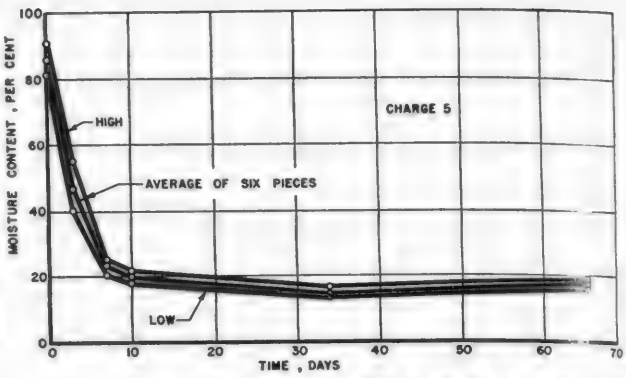


FIGURE 5. MOISTURE CONTENT DURING AIR-DRYING OF ONE-INCH RED ALDER LUMBER AFTER STEAMING AT 120-120 DEGREES F FOR 24 HOURS; AUGUST 7 TO OCTOBER 12, 1953.

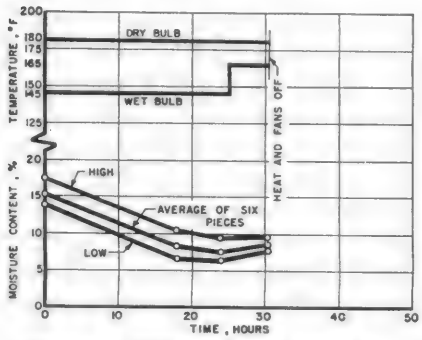


FIGURE 6. KILN SCHEDULE-DRYING RATE FOR ONE-INCH AIR-DRIED RED ALDER LUMBER; CHARGE 1.

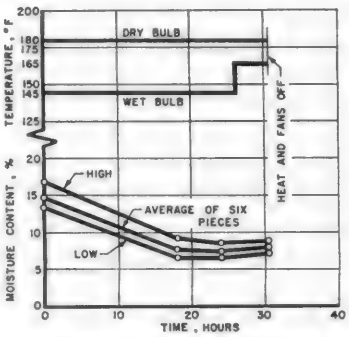


FIGURE 7. KILN SCHEDULE-DRYING RATE FOR ONE-INCH AIR-DRIED RED ALDER LUMBER; CHARGE 2.

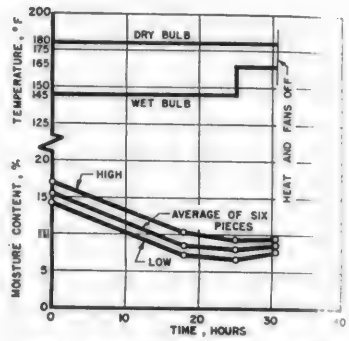


FIGURE 8. KILN SCHEDULE-DRYING RATE FOR ONE-INCH AIR-DRIED RED ALDER LUMBER; CHARGE 3.

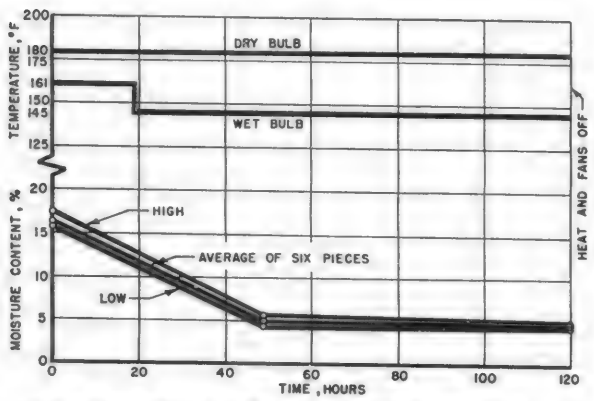


FIGURE 9. KILN SCHEDULE-DRYING RATE FOR ONE-INCH AIR-DRIED RED ALDER LUMBER; CHARGE 4.

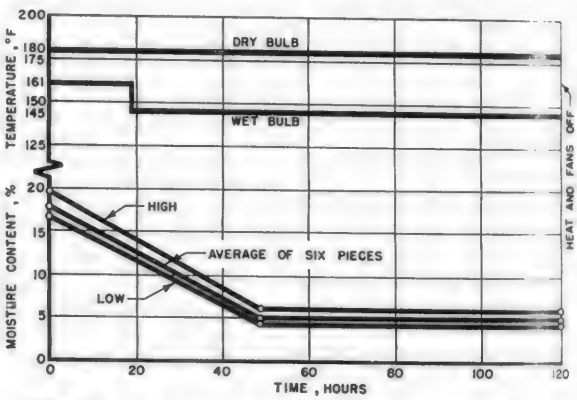


FIGURE 10. KILN SCHEDULE-DRYING RATE FOR ONE-INCH AIR-DRIED RED ALDER LUMBER; CHARGE 5.

from white to pink. Color in charge 3 was unsatisfactory for exposed parts in furniture manufacture.

Charges 4 and 5 were surfaced at the Laboratory after kiln-drying, and inspected for sticker stain.

Charge 4 was free from sticker stain, but contained slight mottling of color. Color in this charge was similar to that of charge 3.

Charge 5 contained sticker stain in 18 per cent of the boards. Color of boards was lighter than that of charge 4, and also had less mottling.

During the inspection of surfaced boards in charges 1 and 2, an improvement was noted also in appearance of tight knots. Tight knots in these charges appeared to have suffered less checking during seasoning and machining than was observed in the commercial lumber currently being run. This improvement was tentatively attributed to the steaming treatment given the experimental lumber before air drying. Subsequent adjustment in initial kiln-schedule conditions in commercial runs resulted in confirmation of this observation. The schedule adjustment made was a change in initial wet-bulb depression from 10 deg F to 5 deg F.

Figures 1 through 5 show the progress of air-drying in the various charges of lumber. All charges air-dried to an average of about 20 per cent m ture content in ten days. Charges 1 th ugh 3 air-dried to an average of ab 15 per cent moisture content in 18 ays. All charges were put out for air- ing in July or August.

After air-drying, charges 1 thr h 3 were kiln-dried to an average 8-9 per cent moisture content in ab 30 hours (Figures 6, 7, 8). Charges and 5 were kiln-dried to an average 8-9 per cent moisture content in ab 40 hours, although these two charge were left in the kiln for a total of 120 urs (Figures 9, 10).

Charges 1, 2, and 3 were kil ried together, as also were charges 4 1 5.

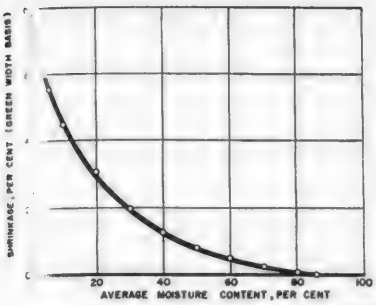


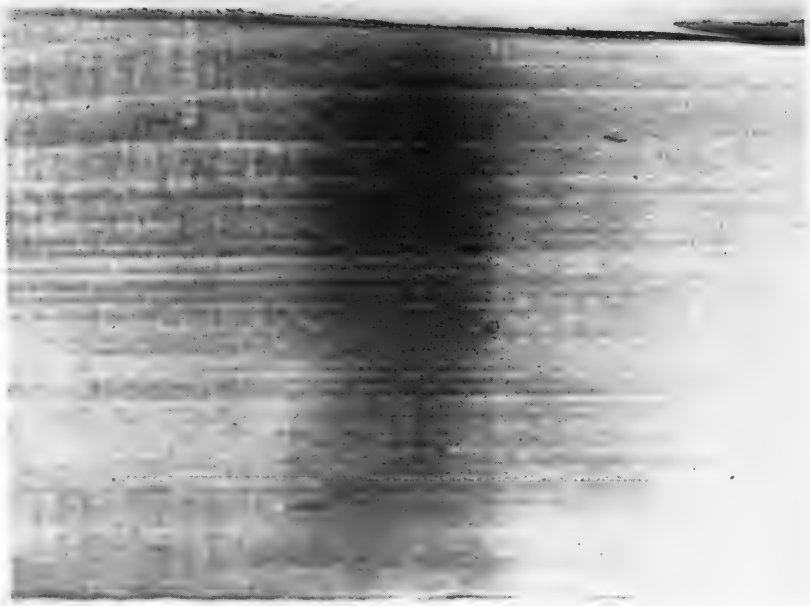
FIGURE 11. AVERAGE SHRINKAGE IN WIDTH DURING DRYING OF ONE-INCH RED ALDER LUMBER.

As can be seen from the drying rates of the kiln samples for the separate charges (Figures 6, 7, 8, 9, 10), the charges in each group dried in much the same manner, regardless of differences in treatment before kiln-drying.

Figure 11 shows average shrinkage in width during drying for kiln samples in all charges. Average shrinkage was 4.5 per cent to an average moisture content of 10 per cent. Average shrinkage was 5.1 per cent to an average moisture content of 7 per cent. Although, not classified, the lumber was largely flat-grained.

Figure 12 gives a cumulative moisture content distribution based on final moisture-meter readings in charges 1, 2 and 3. All the boards gave moisture-meter readings between 7.0 and 11.5 per cent. Ninety-five per cent of the boards gave readings below 10 per cent, and 80 per cent of the boards gave readings below 9.0 per cent. The average moisture-meter reading was 8.8 per cent. The average final moisture content after conditioning of the kiln samples used in the three charges was 8.5 per cent by the oven-test method.

Figure 13 gives a cumulative distribution of shrinkage in width of 18 kiln samples dried to an average of 7.7 per cent moisture content (before conditioning). The average shrinkage value was 4.9 per cent. Ninety per cent of the shrinkage values were 5.5 per cent or lower. Eighty per cent of the shrinkage values were 5.2 per cent or lower.



Sticker stain in one-inch red alder.

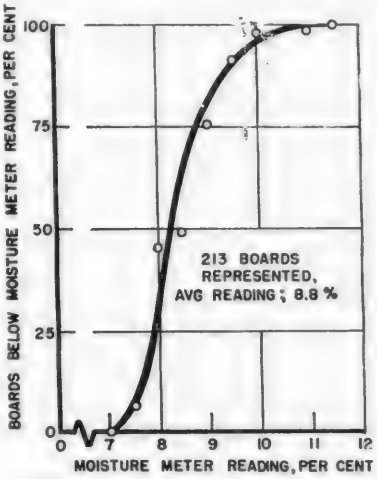


FIGURE 12. CUMULATIVE DISTRIBUTION OF FINAL MOISTURE METER READINGS OF ONE-INCH RED ALDER; CHARGES 1,2,3

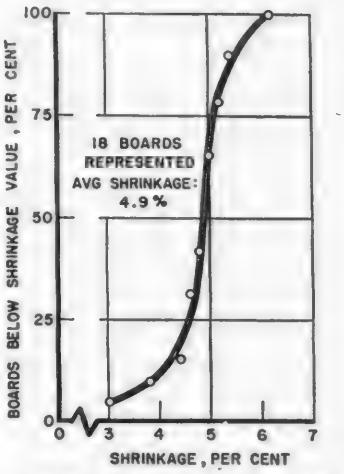


FIGURE 13. CUMULATIVE DISTRIBUTION OF SHRINKAGE VALUES IN ONE-INCH RED ALDER LUMBER DRIED TO 7.7 % AVG M.C.; GREEN WIDTH BASIS.

Conclusions

The immediate objective of this short-term project was to determine the effects of certain preliminary treatments on the development of sticker stain during air-drying. The occurrence of sticker stain during air-drying of one-inch red alder lumber could be eliminated by a steaming treatment of the stickered lumber prior to air-drying.

A desirable and uniform shade of color in the final dried lumber can be obtained by the use of this preliminary steaming treatment. The optimum conditions for this treatment appear to be about 140 deg F dry-bulb temperature, 4 deg F wet-bulb depression, and minimum steaming time about 18 hours. No doubt, adjustments in the shade of color could be obtained by using different dry-bulb temperatures and wet-bulb depressions during steaming. The limited data obtained in this study do not permit exact observations on the color shades resulting from various steaming conditions.

The preceding conclusions are based on the assumption that the lumber will be freshly sawed when subjected to the steaming treatment.

Following the method outlined will allow the operator to take full advantage of air-drying during the summer months, with no losses from sticker staining or undesirable color, and with reduction of 2–4 days in total kiln time needed.

The Semichemical Pulping Process for East Texas Hardwood[1]

MYRON G. KUHLMAN
Technical Director, Fleming & Sons, Inc., Dallas, Texas

Reviews growth of the semichemical pulping process in the south, particularly as related to the use of sweet and black gum in east Texas. Process will increase in importance as demand for paper products continues to soar.

MY ACQUAINTANCE WITH, and my enthusiasm for, pulps produced by semichemical pulping was obtained during the research program my Company has carried out during the past three years.

As most of you know, the semichemical process grew very slowly from it's development in 1925, until after World War 2. Then, because of the great drain on our softwood resources brought about by the unprecedented use of paper and paperboard during this period, the need for hardwood utilization became urgent. Although the production of semichemical pulp increased from ten tons per day in 1925, to 925 tons per day in 1945, and then to approximately 2,650 tons in 1951, the use of this pulp was limited almost entirely to the unbleached grade for the manufacture of .009 corrugating medium.

It is now practically axiomatic that the flat crush resistance of paper made from neutral sulphite semichemical hardwood pulp is the highest obtainable and is largely responsible for the high compression strengths of our shipping containers as we know them today.

Several years ago our East Texas friends began telling us of the large supply of hardwoods in the area which were hindering the regeneration and the rapid growth of the Southern Pine.

Supply

We know that the main pulpwood supply is in the East Texas Pine-Hardwood belt. This is a ten and one half million acre area extending west from the Louisiana border about 125 miles. It starts on the north at the Red River and extends south to Beaumont. In this area, there are about twenty seven million cords of pine available for pulping. But in this area there are about fifty-nine million cords of hardwood available of which about twenty million cords are of excellent pulping species, sweet gum and black gum. The remaining thirty-nine million cords consist mainly of oak. Perhaps fifteen million cords is in red oak. This survey does not include sound trees of sawlog size, but does include the tops or upper stems of sawlog size trees and culls.

A study of the tremendous amount of research being done at the United States Forest Products Laboratory, at Madison, Wisconsin, indicated that our Texas gums were similar in paper making properties to the northern aspen when cooked by the semichemical process.

By this time, several of the more progressive northern paper manufacturers have already been making use of bleached neutral sulphite semichemical aspen pulp in the manufacture of printing paper.

Murfeldt,[2] in his excellent and often quoted article on "Semichemical Sulfite Pulp Made for High Grade Book Paper", seems to have best described the properties of aspen neutral sulphite semichemical pulp as follows; "The unbleached semichemical pulp is characterized by high bursting strength, high tensile, and medium to low tear as compared to spruce or balsam acid sulphite. A high hemicellulose content causes rapid hydration when beaten. For many purposes, the pulp can be considered prehydrated with many of the characteristics of softwood acid sulphite pulp at the same degree of development. The unbleached and the single stage oxidation bleached fibers are quite straight and form a stiff sheet compared to sulphite. The fully bleached pulp is higher in burst, tear and tensile, and the fibers are more flexible compared to the unbleached pulp. The drainage characteristics of semichemical pulp lie between groundwood and sulphite. Its prehydrated quality and its ability to form well with other fibers make it a new and useful ingredient for many paper furnishes."

Now, of course, many of these properties are of great interest to the manufacturer of Fourdrinier and cylinder board.

Many of our cartons, trays, and other forms of containers for food, meat and produce packaging, require a high stiffness to give the product sufficient protection during shipment, storage, and display.

The easy hydrating qualities of semichemical pulp allow the papermaker to apply surface coatings and treatments that give this type of board excellent printability.

It is well known for instance, that it is very difficult to get a good gloss ink print job from an unbleached Southern kraft test liner. Size press and calendar treatments with various starches and gums help considerably, but are relatively expensive to apply. We have found that bleached or unbleached semichemical in the furnish makes this problem much easier to solve.

Useful Additive

With many of our shipping containers requiring three and four color gloss ink printing, it is our belief that semichemical pulp will be a useful additive to accomplish this at a reasonable cost.

The use of unbleached gum semichemical pulp on the secondary headbox with kraft on the primary headbox is showing promise as a means of producing a test liner of excellent brightness, mullen and printability.

It seems to us now, that there are very few grades of folding cartons, containers and building boards that will not benefit by the addition of semichemical pulp in either the bleached or unbleached form. Its hydration and forming characteristics should enable it to push sulphite pulp out of many grades. Its greater strength and versatility should make inroads in the use of groundwood. The high density and yields obtained with our East Texas hardwoods will make the costs attractive when compared with any other pulping process.

[1] Presented at meeting of the Forest Products Research Society, Deep South Section, November 9-10-11, 1953, at Lufkin, Texas.

[2] Murfeldt, L. W., Paper Trade Journal 130, No. 26-27-29, June 1950.

The attainment of these goals is, of course, not without its problems. For instance, the methods of harvesting and transporting hardwood pulpwood must be improved to reduce the cost disadvantage of delivered hardwood pulpwood as compared with the cost of pine pulpwood.

It is not yet possible for many of our board grades, to go through a forest and cut the hardwood species as they stand and then cook them in a mixed furnish. The predominance of oak species in our East Texas woodlands, with it's short fiber and difficult barking problem, adversely effect the bender and cleanliness of folding cartons made mostly from oak semichemical pulp even when blended with bleached kraft pulp.

The first day's program of this group's meeting on bark removal indicates your recognition of this problem, especially for hardwood. We have not yet found a method of barking that combines both efficiency and high production at all seasons of the year. However, with the great amount of co-operative effort between machinery manufacturers and pulpwood users now bearing upon the problem, I feel sure it's solution is not far away.

The problem of stream pollution is getting the constant attention of some of the best minds in the industry. To the prospective pulp mill owner today, the problem of waste disposal is as important as wood supply, water and transportation facilities.

Refining Stage Critical

Even though the importance of the foregoing problems cannot be overemphasized, it seems to me that the most critical phase of semichemical pulp production, is the refining stage. Because of its easy hydrating characteristics, it is all too easy to "over refine" a semichemical pulp and make it too "slow" for good drainage and formation on the cylinder mould.

Most paperboard mills, in the manufacture of the many folding carton grades, require numerous furnishes where bleached kraft, bleached semichemical and groundwood or waste paper are refined together for top liner stock.

If we blend in the beater a furnish of, say, bleached kraft at 650 freeness, bleached semichemical at 400 freeness and groundwood or waste paper at 250 freeness, the problem of refining this mixture of varying fiber lengths and hydration characteristics for a well formed liner of three or four points thickness is readily recognized. The Kraft hydrates slowly, the semichemical rapidly, and groundwood or waste paper lies somewhere in between. Add to this the fact that the semichemical pulp may contain gum, oak, elm, cottonwood, willow or a mixture of all five species, and we compound the problem many fold. Since the hardwood fiber is already a short one, any further cutting may ruin the "bender" or ability to score the sheet without cracking of the fiber.

Of course, we always have had this same problem with our mixtures of pulp and waste paper stock in the waste paper field. We rarely have a top or under liner stock with less than three different types of fiber to refine together, in the many grades we manufacture. Further than this, these waste papers are not simply long virgin kraft fibers, and short fibered groundwood pulps, but heterogenous combinations of all of these fibers that have already been refined at least once. With the help of such useful tools as fiber classification studies and the rapid development and application of the disc refiner in recent years, much has been learned in this field of handling fibers of all kinds.

The refiner manufacturers themselves are giving much of their time to the study of the refining of semichemical pulp. They are constantly engaged in studies of multi-stage refining, separate refining of the stocks and blending at the machine headbox as well as new designs of refiner plate patterns.

In this same connection, I cannot overemphasize the work being done at institutions such as the United States Forest Products Laboratory at Madison, Wisconsin. They are constantly studying the effect on pulp strength of such variables as chip size, chip moisture, refining temperature, consistency, feeding rate and multi-stage refining.

The result of this work is enabling mills to make use of hardwood species formerly considered unusable.

This brings us to the main problem in the utilization of East Texas hardwoods. The predominance of the oak species in this area, as cited earlier, makes it almost mandatory that we use it as much as possible for adequate forest utilization.

This species is harder to harvest and more difficult to bark than other woods. Since it has a shorter fiber than gum, it presents problems in pulping and refining that have not, as yet, been satisfactorily solved.

The use of oak in the production of .009 corrugating medium is an accomplished fact. We have been successful to a certain extent in its use in the manufacture of unbleached and bleached semichemical board grades when mixed with other woods. At present, it is inferior to gum in these applications, and the percentage allowable is not as large as we would like.

We are hopeful that studies along the lines previously mentioned, will bring about a utilization of this species proportionate to its growth in our East Texas area.

Before closing, I should like to mention that the further development of the cold soda process of semichemical pulp production offers great promise for the quick utilization of our hardwoods. This process was developed several years ago at the United States Forest Products Laboratory at Madison. It consists of soaking of wood chips in a caustic soda solution for several hours at room temperature. The very high yield is usually around ninety per cent and after removal of the black liquor the softened chips are fiberized in the usual manner.

Economic Advantages

The economic advantages of such a process are obvious. The unprecedented high yield, the absence of high pressure vessels and steam savings make the costs attractive.

When used as one hundred per cent of the furnish in corrugating grades, it is not quite as high in flat crush resistance. However, when used with a neutral sulphite semichemical pulp, it has many advantages.

Studies with the use of pressure to increase the uniformity of liquor penetration of the chip, indicates that new and important applications of this type of pulp are near at hand.

Even the bleaching of this pulp shows promise despite its high lignin content. Of course, this process is still in its infancy, but it is one of a series of developments, which have as their goal, the profitable use of our huge hardwood supply.

Future Developments

The further development of a continous system of pulping is also being studied with interest. Pulpers such as Chemipulper and the Messing–Durkee pulper offer economies in space savings and steam consumption. They also offer the possibility of better control of quality during the cooking cycle.

These developments are mentioned in passing, only because they indicate trends in semichemical pulping and, as such, are bound to influence the use of hardwoods in paper board manufacture. Such developments plus the extensive study of refining methods and equipment development should enable us to make a semichemical pulp to suit the grade requirements rather than the other way around.

If any further incentive is needed to carry on the development of hardwood semichemical pulping an article in the February 1953 issue of Fiber

Containers magazine merits your consideration.

The article, by Dr. John E. Gates,[3] Dean of the College of Business Administration, University of Georgia, is entitled "Paperboard Unlimited—An Economic Evaluation". He says, in part: "Barring any unforseen depression, or whatever it is that changes our outlook toward reproduction, population in 1960 is likely to be around 175 million people. The Bureau of Census estimates run from 165 million as its "low series" to 180 million as its "high series". In any event, the 175 million figure seems to be destined to be reached within a few years of 1960, based on current estimates.

If, on the other hand, paperboard usage rises from the current 167.5 pounds per capita to 195 pounds, which seems not too unreasonable, the total production of board in 1960 must be 15,000,000 tons, or about 31% above the 11,840,600 tons produced in 1951. At 80 percent capacity operations, this will require an increase of 4½ million tons in annual capacity, beyond the 1951 estimate of 12,596,400 tons of capacity."

[3] Gates, Dr. James E., Paperboard Unlimited. An Economic Evaluation. Fibre Containers and Paperboard Mills. Vol. 38, No. 2, Pages 34-46.

Under the heading, "Implications to the Board Industries," Dr. Gates continues:

"There are grave implications in the above to the members of the paperboard group of industries.

"The impact on the industry will be uneven, as will the geographic distribution of new facilities. Increases in population will likely come in the newer areas of the United States, as in the South and on the Pacific Coast, and new converting facilities are likely to be established there. In the board end, it seems inevitable that there will be a scramble for such sites as remain for production of Kraft boards, principally within the South, and perhaps on the Pacific Coast. Whether there will be enough pulpwood resources to support a one third increase in production of board would require considerable study.

"It seems likely however, that we shall not be able to supply this increased demand from virgin fibers produced in this country alone, and this may well mean resurgence of the Jute facilities or the introduction on a much larger scale of the double head box on Southern Kraft Machines, to get a proportion of waste products into the former homogenous Kraft boards. Little relief can be expected from any possible conversion of paper facilities to board, for the demand for paper products will probably rise by the same proportions as the demand for paperboard. Similarly, with sanitary boards—which must be all virgin fiber—and book papers, which will likely be, in fact, invading the board facilities to get paper, in the same manner as in the immediate Post World War 2 period."

Even if this estimate should prove too optimistic, there seems no doubt that we shall need all of our hardwood resources to keep pace with our industrial growth.

It is also evident that both waste paper and virgin fibers will fill their economic and utilitarian needs not so much in competition with each other, but rather as complementary materials for the production of better paper boxes.

The Use of Urea Resin Glues in Radio Frequency Lumber Edge Gluing[1]

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Describes use of urea resin glues under production run with particular reference to proper use of catalysts, the addition of water, and the effect of such factors as electrolytes, glue spread, moisture content of the wood, and type of wood.

UREA RESIN GLUES have been used in the RF field since gluing by radio frequency was first born and they continue to be the most adaptable and economical tpe of adhesive for this application. Some of the advantages of urea resin glues over other types are, (1) the increased speed of bonding which reduces the processing time, (2) heating is restricted to the glue line and the whole assembly is unaffected with respect to moisture content, (3) reduction of glue costs, and (4) saving of storage space since the lumber assemblies can be processed immediately out of the machine.

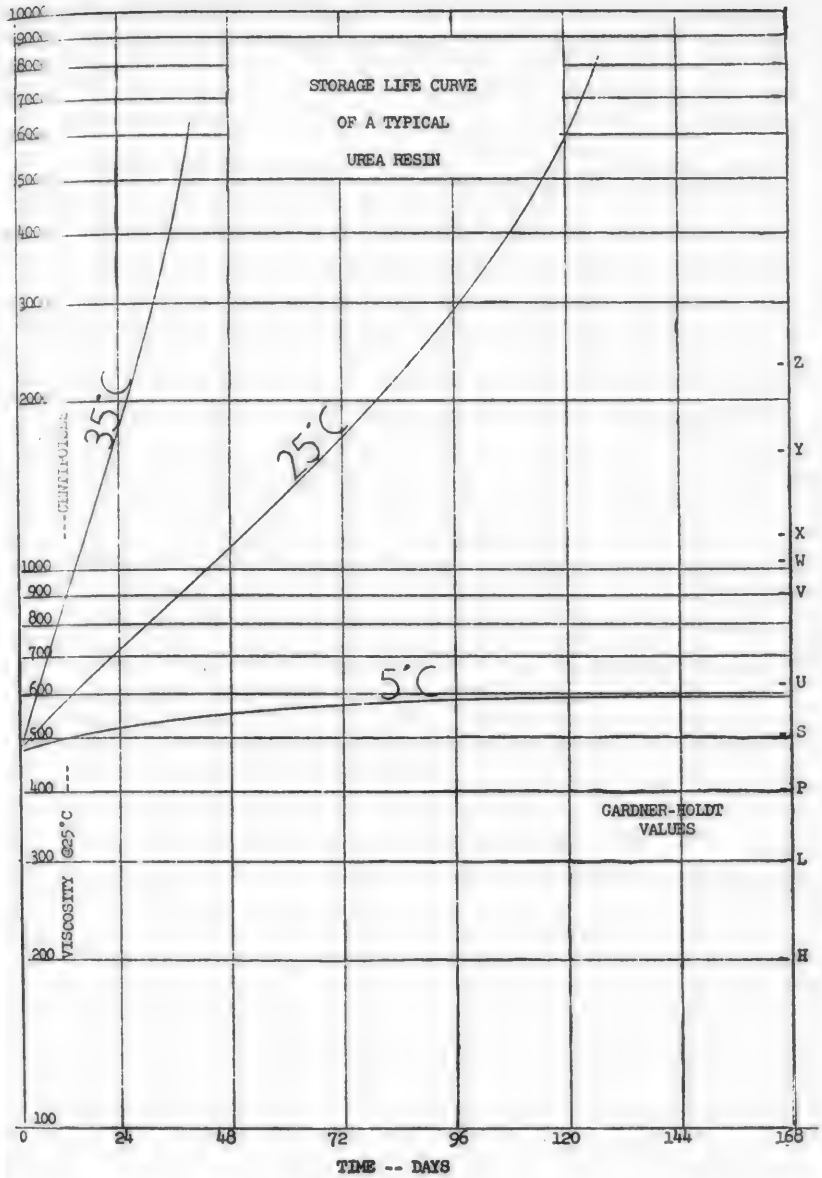
Urea Resins

The term "urea resin" is applied to the reaction product of urea and formaldehyde. This reaction product is formed by allowing urea and formaldehde to react under mildly alkaline conditions to form dimethylolurea. This product is then capable of reacting with itself, under acidic conditions, to yield a complex cross-linked polymer(polymerization). This polymerization is accomplished by acidification of the solution of dimethylolurea. When the desired degree of polymerization has taken place, the reaction is then "stopped" by neutralization of the acidic solution. This neutralization slows the rate of polymerization to a lesser degree, so that the resin will have a reasonable storage life. At this point the resin is dehydrated to the proper solids content before storage. The resin is now in the form in which the customer receives it.

Urea resins for the gluing industry are, usually, colorless liquids with a given solids content and a definite viscosity. The resin is ready for immediate use after mixing with a given amount of a catalyst, and water (if necessary). Urea resins are stable and usable for relatively long periods of time; however, the effect of warm temperature on the resin reduces the storage life, as with other types of resin glues. For example, a urea resin which has a usable life of 6–9 months at 25° C. (77° F.) will have only a 3 months life at 35° C. (95° F.) but will have a storage life of over 12 months at C. (41° F.). The storage life of a resin is measured by the rate of viscosity increase over a period of time. Once the viscosity has reached a predetermined value, the resin is considered to be unusable for normal production gluing.

The age of the resin at the time of use will have an effect upon the cure speed and pot life of the glue mix. For example, a glue made with fresh batch of resin will have a slightly longer pot life than a glue made with resin that is near the end of its storage life. This may amount to one-half hour

[1] Presented at meeting of the Forest Products Research Society, Northern California Section, April 23, 1954, at San Francisco.



or more depending upon the condition of the resin; however, this is not a serious problem, generally, since the resin is used before it reaches the end of its storage life.

Urea Resin Catalysts

A catalyst acts as the agent for increasing the rate at which a urea resin polymerizes, or "sets". In order for a urea resin to "set" in a reasonable length of time it is necessary to reduce the pH (acidity) of the resin. This is accomplished by the addition of a urea resin catalyst. This catalyst is composed of an acid salt, a buffering agent, and an inert filler. After mixing the resin and catalyst together, the resulting glue mix has a definite working life and pot life. All urea catalysts have been formulated to yield a predetermined working life and cure time and any change in the mix proportions will have a definite effect on the performance of the glue.

Urea catalysts are usable indefinitely, if kept dry and covered; however, most urea catalysts for RF application will absorb moisture from the air, if left uncovered, and will lump. This may result in inaccurate catalyst weights if too much moisture is absorbed and then weighed as "catalyst". The additional water in the glue mix will lengthen the pot life slightly and will slow the cure speed noticeably.

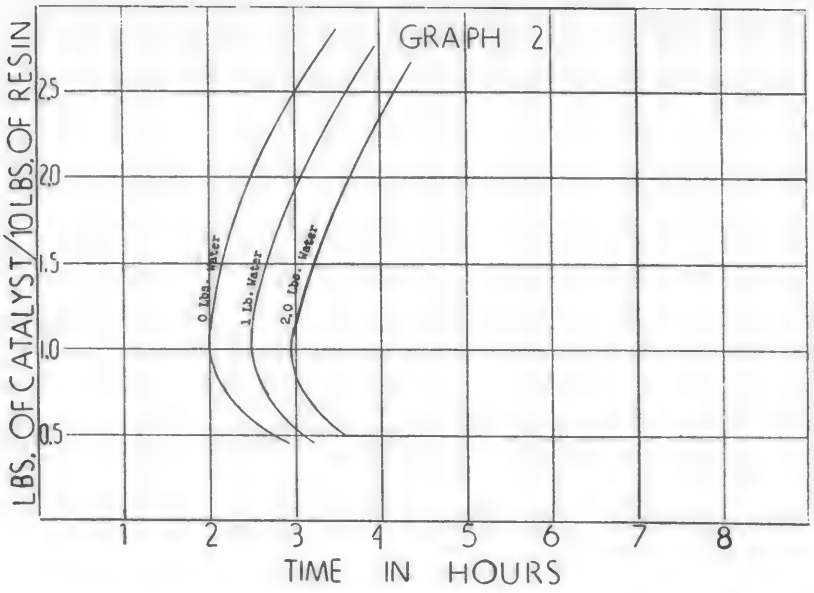
Effect of Catalyst on Working Life

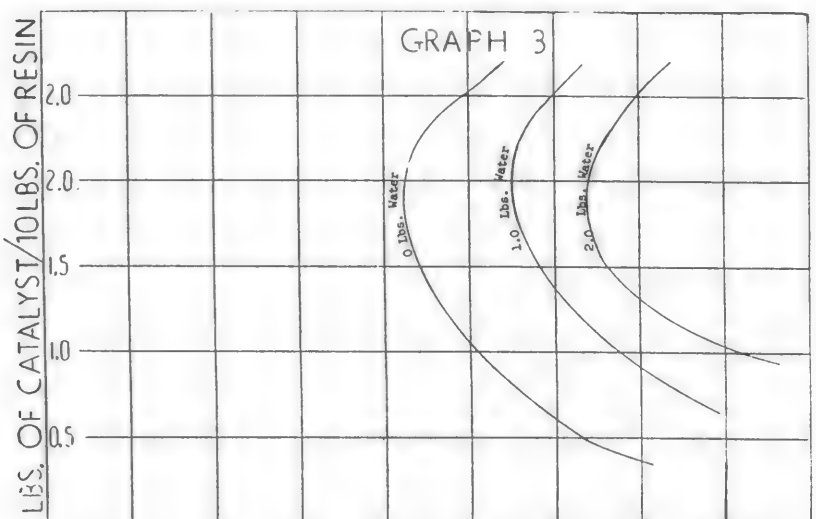
The amount of catalyst added to a given weight of resin has a definite effect on the pot life, viscosity, and cure rate of the glue. Graphs 2 and 3 show the effect of different amounts of catalyst, per a given weight of resin, on the working life of two different glues. Graph 2 shows the effect of a stronger catalyst (more acidic) upon the pot life of the mix, as compared to the same weight of a weaker catalyst (less acidic) as shown in Graph 3. For example, in Graph 2 a glue composed of two pounds of Catalyst No. 1, per 10 pounds of resin, with no additional mixing water present, has a pot life of 2½ hours. In Graph 3 a glue composed of two pounds of Catalyst No. 2, per 10 pounds of the same resin, has a pot life of 4¼ hours.

For a given catalyst and resin, the glue manufacturer has definite mix instructions. These instructions are designed to yield a glue mix which will be the most adapatable to a given customer's requirements. Graph No. 2 shows the effect of increasing or decreasing the amount of catalyst added to a given amount of resin. For example, a glue mix composed of 10 pounds of resin, 2 pounds of Catalyst No. 1, and no mixing water, has a pot life of 2½ hours. If the amount of catalyst were decreased to 1 pound per 10 pounds of catalyst the pot life would be 2 hours. The effect of reducing the amount of catalyst is to reduce the working life of the glue. Conversely, increasing the catalyst to 3 pounds per 10 pounds of resin will increase the usable life to 3 hours. The effect of less catalyst than the mix requires is that the relative amount of buffering agent present to resist the action of the acid salts is lessened. If no buffering agent were present in the catalyst, the resin would set in a few minutes due to the action of the acidic chemicals. Increasing the amount of acid agent, by increasing the amount of catalyst, does not have the expected effect of reducing the working life since the acid concentration of the solution is more than sufficient to do so with less catalyst. The additional buffering agent added with increased catalyst has a definite effect, since it will resist a change in pH more strongly due to the increased concentration.

Effect of Water on Pot Life

In general, the effect of additional water added to a urea resin-catalyst glue mix is to increase the working life of the glue. This refers, of course, to water combined with resin and catalyst at the time of the original mixing. Graphs 2 and 3 show the effect on working life of increasing or decreasing the amount of water in a given urea resin-catalyst system. The amount of water can be adjusted for purposes of viscosity control; however, this should not be done without the glue manufacturer's approval since the spreading and penetration properties of the glue will also change. Naturally, there is a point of dilution beyond which the glue would be unusable. Graph No. 2 shows that a





10 pound mix of resin, 2 pounds of Catalyst No. 1, and 1 pound of water, has a pot life of 2½ hours. If no water had been added the pot life would be 2 hours. If the water had been increased to 2 pounds the pot life would have been 3 hours.

Effect of Temperature

The rate at which a urea resin glue sets at a given temperature can be measured by observing the rate of increase in the viscosity of the glue mix. Urea glues are relatively slow setting for the initial portion of the working life; however, once the pH has lowered sufficiently the setting action is very rapid. This can be seen in Table No. I. The increase in viscosity during the first hour of the life is slow—however, at 2-2½ hours the increase is rapid for Catalyst #1 and it is also rapid for Catalyst #2 at 4-5 hours.

Table I.—TYPICAL VISCOSITY VALUES OF STANDARD MIXES OF CATALYST #1 AND CATALYST #2

Catalyst #1	Elapsed Time	Catalyst #2
1500 cps	0	780
1900 cps	1 Hour	
2000 cps	1½ Hours	980
7000 cps	2½ Hours	
Unspreadable	3 Hours	1350
	4 Hours	2100
	5 Hours	3750
	6 Hours	Unspreadable

Note: A viscosity of greater than 10,000 cps is considered unspreadable for normal use.

Standard Mix of Catalyst #1	Standard Mix of Catalyst #2
10 Lbs. of Resin	10 Lbs. of Resin
2.0 Lbs. of Catalyst	2.0 Lbs. of Catalyst
10.5 Oz. of Water	1 Lb. of Water

The effect of temperature on the glue mix is to decrease the working life as the temperature increases and to increase the working life as the temperature decreases. An increase of 10° F. in the temperature of the mixed glue may reduce the working life by as much as 1-2 hours. This is one factor which must be controlled during the warm summer months, when the temperature of the resin, catalyst, and the air is several degrees higher than during the winter.

The effect of the temperature upon the usable life of the mixed glue is shown in the following table of pot lives at three different temperatures. In each case a standard mix of 10 pounds of resin, 2 pounds of Catalyst No. 1, and 10.5 ounces of water was used.

	Temperature		
	15°C	25°C	35°C
Pot Life in Hours	4½ Hrs.	3 Hrs	2 Hrs

Effect of Catalyst on Cure Speed

The cure time of a glue is defined as time required to "set" the glue to a hard mass. This time will vary with the strength of catalyst and the temperature of glue. Tables 2 and 3 show the cure times of two different catalysts as measured by a laboratory model RF generator. All cure times are of the resin alone and not of a wood-glue-wood joint; however, the cure times established in the laboratory follow closely with those in field applications. For example, a slow curing glue under laboratory conditions will be a slow curing glue under field conditions. The cure times shown are approximately twice as long as the cure times obtained on a larger production model RF machine using normal gluing conditions. (See TABLE 2 and TABLE 3.)

In TABLE 2 the cure speed of the standard mix is 75 seconds. When the catalyst is increased to 2.5 pounds, the cure speed is lengthened to 80 seconds, but when the catalyst is reduced to 1.5 pounds the cure speed is shortened to 73 seconds. The difference that was noted on this small scale would also be noticed on a regular machine where a few seconds cure time can mean producing or not producing. It can be seen from these tables that there is a noticeable difference in cure times with small changes in the amount of catalyst. TABLE 2 shows the cure times of various glue mixes of Catalyst No. 1 and TABLE 3 shows the cure times of various glue mixes of Catalyst No. 2. The difference in cure speed is analogous to the difference in pot life of the two catalysts and can be attributed to a large extent to the strength (acidity) of the catalyst.

Effect of Electrolytes Upon Cure Speed

If a urea glue is to operate efficiently under RF heating conditions, it must be as receptive to the RF current as is practical. This can be accomplished by incorporating a "conducting salt" in

the glue. Salt (NaCl), being a good conductor of electric current, has been included in most RF urea catalysts. The effect of the salt on the pot life of the glue is small compared to the effect upon the cure speed under RF. RF heating is very selective with respect to the path it takes and since the salt makes the glue line more receptive, the faster the cure will be if all, or the

Table 2.—CURE TIMES OF CATALYST #1

Amt. Catalyst per 10 Lbs. Resin	Amt. of Water per Mix	Ave. Cure Time in Secs.
2.5 Lbs.	0	70 Secs.
2.0 Lbs.	0	60 Secs.
1.5 Lbs.	0	60 Secs.
1.0 Lbs.	0	70 Secs.
0.5 Lbs.	0	90 Secs.
2.5 Lbs.	26 Oz. H_2O	80 Secs.
2.0 Lbs.	26 Oz. H_2O	75 Secs.
1.5 Lbs.	26 Oz. H_2O	73 Secs.
1.0 Lbs.	26 Oz. H_2O	90 Secs.
0.5 Lbs.	26 Oz. H_2O	100 Secs.
2.5 Lbs.	52 Oz. H_2O	100 Secs.
2.0 Lbs.	52 Oz. H_2O	80 Secs.
1.5 Lbs.	52 Oz. H_2O	85 Secs.
1.0 Lbs.	52 Oz. H_2O	80 Secs.
0.5 Lbs.	52 Oz. H_2O	120 Secs.

*Standard Mix. Pot Life of standard mix=3 Hours @ 25°C.

Table 3.—CURE TIMES OF CATALYST #2

Amt. of Catalyst per 10 Lbs. Resin	Amt. of Water per Mix	Ave. Cure Time in Secs.
2.5 Lbs.	0 Lb.	75 Secs.
2.0 Lbs.	0 Lb.	75 Secs.
1.5 Lbs.	0 Lb.	70 Secs.
1.0 Lbs.	0 Lb.	70 Secs.
0.5 Lbs.	0 Lb.	95 Secs.
2.5 Lbs.	1.0 Lb.	85 Secs.
2.0 Lbs.*	1.0 Lb.	75 Secs.
1.5 Lbs.	1.0 Lb.	75 Secs.
1.0 Lbs.	1.0 Lb.	80 Secs.
0.5 Lbs.	1.0 Lb.	100 Secs.
2.5 Lbs.	2.0 Lbs.	100 Secs.
2.0 Lbs.	2.0 Lbs.	90 Secs.
1.5 Lbs.	2.0 Lbs.	85 Secs.
1.0 Lbs.	2.0 Lbs.	85 Secs.
0.5 Lbs.	2.0 Lbs.	130 Secs.

*Standard Mix. Pot life of standard mix=4–5 Hours @ 25°C.

major portion of the current, passes through the glue line. For all urea glues, there is a point of maximum conductance, beyond which arcing or burning will occur. An arc is the result of a too conductive glue line which allows the current to pass too readily from one electrode to the next. The electrodes in a typical RF lumber edge gluer are arranged so that the current will pass through the glue line in a Z pattern and the glue that is cured immediately represents approximately one-third of the total glue line area. This degree of cure is sufficient to provide adequate strength of the glue line for subsequent handling out of the press. The remainder of the glue line will "cold set" in a short time. The length of time required depends on the amount of heat retained in the assembly and the conditions of storage.

A urea glue line designed for curing in an RF lumber edge glue press will usually cure in 30-40 seconds or less under average production conditions and will provide a strong, durable glue joint. The rate of cure will depend upon the individual machine, stock thickness, moisture content, glue conductivity, and other factors present at the time of gluing.

Effect of Glue Spread

The amount of glue present on the glue line at the time of gluing has a definite effect on the cure of the glue. This amount is critical, particularly if only one side of a joint is spread with glue. The mechanical glue spreaders accompanying each operation can be adjusted to give a desired amount of spread and it is necessary to adjust this spread so as to obtain good transfer to the opposite face of the joint when the assembly is pressed and yet not enough to yield a large bead of "squeeze out". All thermosetting glues will thin somewhat on heating and will squeeze out of the joint, particularly if edge pressure is high. Excess glue on the surface of assembly will provide a "path" for the current when the assembly is put in the press. The current will cure the glue on the surface in preference to the glue joint and may "arc". Once an arc has occurred the voltage automatically drops and the glue line is left uncured. The danger of under spreading can readily be seen. Insufficient glue for good transfer will result in a weak glue joint. The spread is at an optimum when a small bead of cured glue is noticed on the glue joint after pressing.

Mixing the Glue

All urea catalysts and resins for RF gluing have been formulated to give optimum results on a given machine when mixed exactly as the glue manufacturer recommends. The mix instructions are simple enough, since it is only necessary to add a weighted amount of catalyst to a weighted amount of resin, milx a few minutes and then add a given amount of water, if necessary. Any deviation from these mix instructions will result in variations as outlined previously.

Moisture Content of the Wood

The RF lumber edge glue machines now in use in the Pacific Northwest are designed for gluing lumber of 8-12% moisture content. Lumber with a moisture content of up to 20% can be glued—however, the cure speed is slower and production is less. The lumber used should be of a uniform moisture content since any "wet spots" will lead to under cured glue lines or "arcing" and loss of production.

Type of Wood

The species of wood, the density, and the presence of any extraneous matter, such as pitch, are important factors to be considered when RF gluing with urea glues. The urea glue will have to be adjusted for different species of wood so as to prevent, for example, excess penetration on less dense wood and lack of sufficient penetration on more dense woods. This can usually be accomplished by varying the amount of water in the glue mix; it should never be done without the glue manufacturer's consent.

Condition of Stock

All edges of the lumber should be freshly jointed and free from warps or other defects. High speed saws will produce an adequate joint; however, the better the wood joint the better the glue joint. Stock thickness will vary from press to press but an attempt should be made to use uniform thickness stock in each press load to minimize pressure problems.

Conditions of Pressing

The RF generator should be adjusted to the maximum output of power to produce the most rapid cure. This will be at a point just short of arcing in the glue line. The edge pressure should be adjusted to provide 100-200 psi on the assembly, depending upon density and thickness of lumber used. The top pressure should be at 10-15 psi to provide sufficient pressure to prevent any "buckling" of the assembly.

In general, the following points can be assumed to be true for most urea glues which are composed of a urea resin and a buffered catalyst:

1. Increasing the amount of catalyst will tend to lengthen the working life and the cure time.
2. Decreasing the amount of catalyst will tend to decrease the working life and the cure time.
3. Adding more water will lengthen the working life and cure time and decrease the viscosity of the glue.
4. Reducing the water used will shorten the working life and cure time and increase the viscosity of the glue.
5. A minimum spread is needed to reduce "arcing" tendency.
6. Temperature of glue has definite effect on working life.

The higher the temperature, the shorter the working life.

If the simple controls of storage, mixing, and temperature of the resin are observed, the urea resin will supply a glue of wide application and satisfactory performance. Urea resin glues will continue to improve and advance with the rapidly growing field of gluing by radio frequency heating.

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Product and Process Variables Related to the Effect of Moisture on Hardboard[1]

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This paper, in attempting to evaluate operating variables as they effect the hygroscopicity of hardboards, necessarily applies mainly to the author's experience with the wet-bath process, using Asplund Defibrators for defiberizing and Douglas fir wood as raw material. However, many basic factors may be applied to all present hardboard processes with modifications.

THE CHIEF VARIABLES influencing moisture relations of hardboards can be traced through almost every step of the manufacturing process, and almost any change made in operation may have its significant or insignificant influence on these properties. From the raw wood to the storage of the finished product, however, all of these may be grouped under five or six key headings as they directly relate to moisture, as follows:

1. The physical and chemical make-up of the wood itself.
2. The modifying and defiberizing treatment given the wood.
3. Chemical additive treatment and internal sizing.
4. Densifying and internal bonding effectiveness of the boards.
5. Subsequent treatment of the boards after pressing.

The Wood Itself

As to how great the influence of the raw material is upon the final product of hardboard little is definitely known, but certainly with a material as variable as wood the problem begins here. To begin with, all types of sources for wood are encountered in the industry, some from salbs and millwaste, others from peeler cores and veneer clippings, others from whole logs and pulpwood, and still others from planer shavings, sawdust and the like. Each type may have its effect on board properties and cause mill-to-mill differences not easily explained in any other way. Here too, no doubt, site quality, climate and region of growth, soil conditions, etc., contribute factors influencing wood-formation that all play their part in the variability of wood supply.

The species and the angiospermous or gymnosperous origin are generally regarded as the most influential factor in wood differences. A variety of species is being used in different mills with varying success, and the source and type of wood supply are also greatly different for the same species. Many of the product variables, including many relating to moisture, can be related to the wood.

As for species, many tests have been run on the practicality of almost all common woods for hardboard manufacture, including some made by Chapman Manufacturing Company in mill tests. But, although our main supply is old-growth Douglas fir millwaste, and we must be content with it, we have also found this to be best from the standpoint of our water-resistance requirements, as opposed to hemlock and true firs. Whether or not this agrees with the results of others is not known.

Within the species, especially one as variable as Douglas fir in growth and growing conditions, many other factors may be equally important in determining hardboard properties. The natural variation of wood as regards texture of the fiber—coarse or fine [illegible]wth, summer or spring wood, wood with thick or thin walls, young growth or old growth, compression wood or normal wood, decayed wood or sound [illegible] or rosin or the lack of it, bark or no bark—these and other variations can all have their effect upon moisture properties. Some of these are well known factors—others, not so well understood or even considered of importance.

For instance, Anderson and Runkle have patented the use of resinous wood in hardboard, as well as the utilization of the free bark wax for sizing. Others try to eliminate these very factors in the manufacture, and there is often difference of opinion as to their desirability.

Our company, in studying some of these wood-to-product relations has experienced improved sizing with pitchy mill rejects included in the wood supply, and this along with many other factors makes us a little partial to old-growth Douglas fir as a raw material. But, it has been our experience to find trouble with young growth Douglas fir as related to water absorption of the board, whether it be from lack of natural resins, cellulose structure, a preponderance of sapwood and young growth, water content, fiber structure, or some other factors. We cannot definitely pinpoint them, but we are convinced of the undesirability of this type wood as we now operate. A few figures will serve to illustrate this point. Data developed shows that with old growth fir with considerable pitch that the average water absorption was 7½ percent and swelling in thickness was 12½ percent. With young growth of primarily slabs and edgings with little or no pitch under the same or very similar operating conditions, the [illegible]r-

[1] Presented at meeting of the Forest Products Research Society, Hardboard Division, Pacific Northwest Section, February 1, 1954, at Portland, Ore.

ages were 24 percent for absorption and 14½ percent for swelling. Here too, [illegible] included a certain amount of hemlock and white fir, run through with the small fir young-growth and small old-growth. Halloquist has shown experimentally with the semi-dry process that hemlock and true firs give poorer water resistance than boards made with Douglas fir, but work done at the Oregon Forest Products Laboratory on one company's fiber does not agree with these results. However, our results tend to substantiate Halloquist, and certain factors in this wood seem to make sizing or other water-resisting treatment of the board difficult.

Modification and Fiberizing of the Wood

In the cooking process or defiberizing another group of conditions influences the resistance to the board to moisture. The methods and conditions of defiberizing and refining are of importance in modifying hygroscopicity. The time and temperature and moisture used in heating the chips to the defibering stage is varied from mill to mill, depending on equipment and mill conditions, but these must also be varied with the species, chip-size, chip moisture and temperature, the water condition, temperature and pH. Here the main factors are the plasticity of the fiber, with the resultant effects on the densifying of the board, and the chemical modifying of cellulose, lignin and extractives by heating. This treatment may influence the retention of water solubles in the pulp mixture and attraction for the chemicals later added to the pulp. Retention of certain water-soluables such as natural rosin for sizing and hemicellulose binding agents are altered by washing of fiber, or screening and may serve to eliminate these to the detriment of the final product. The temperature and time of heating serve to determine the plastic-compressing properties of the fiber, along with the resulting size of fibers obtained. Large shives may retain their resiliency during pressing and cause greater swelling than normal for more uniform fibers. Fine fibers may tend to stay compact to a high specific gravity. Any fibrilizing or shortening of the fibers, however, may tend to expose more fiber surface to water by breaking off ends of fibers to allow more surface area for water attraction. Of course, in the cooking or fiberizing process we cannot overlook the effect that any addition of size or chemicals at the cooker or refiner may have and the pH of the pulp due to cooking.

As the more or less untreated pulp comes from the refiners, several more factors may influence moisture relations of the final product. The temperature, pH, and condition of any dilution water may be important, together with the sizing influence of any white-water reused in the system. Hard water, supposedly, has a detrimental effect on the sizing effectiveness of alum mixtures due to the formation of a size-inhibiting aluminum floc. The temperature and pH of the pulp will have their own influence on the sizing and attachment of the binding agents.

Additive Treatment and Sizing

Chemical addition plays the most important part in the resistance to boards to moisture, but many variables occur here that can greatly influence the final results. First, the completeness of dispersion of the additives seems most necessary, with complete agitation and a low enough consistency to allow this helping to equalize this troublesome factor. Excessive beating, however, may break down the fibers into fines and loosen precipitated particles from fibers, according to some authorities.

In the actual addition of chemicals to the stuff, the sequence of addition may vary from mill to mill, but each mill has its own most effective method. At Chapman we have found that complete dispersion of resin, then wax emulsion, then alum and acid gives the desired results. The control of pH both prior to and after additives varies greatly in mill to mill, but low pH's of below 5.0 are most common throughout the industry. In our experience we have found that pH values below 4.5 are more effective in reducing moisture absorption than those around 5.0 or higher. A few figures will serve to show this. Our water-absorption results made over a period of time with pH controlled to 4.0–4.2, after additives, averaged 2½ percent lower than when boards were made with a pH control of 4.8–5.0. One-eighth inch board with the lower pH control averaged 15½ percent absorption and 12 percent swell, whereas, the same board with control to approximately 5.0 gave absorptions of 18 percent and swelling of 14 percent under the similar operating conditions. Two resin companies' results tend to verify this in wet process experiments. Our mill uses alum and sulfuric acid in approximately 60–40 proportion, but others may use inorganic acids, ferric sulphate and sodium aluminate for precipitating.

The types of additives used play their respective roles in water relations of hardboards, and arguments may be given for even brand names by staunch supporters. Of course, the type of sizing agent and the amount and methods of application are self-evident in their effect on sizing, several types of sizes being available on the market—such as wax-emulsions, rosins, bituminous emulsions and solid waxes ground on by mechanical means. However, with all of these, alum or other ionizing agents and pH control are necessary. Effectiveness may vary with the type of size used, but within the type, results are usually proportional to the amount applied and sizing effectiveness. One plant, as explained before, used the natural wax of fir bark to size its boards very satisfactorily.

Resins differ mostly with type of process, and each is fairly well-tailored to the individual plant use, so another important variable appears here. The nature of the binder has an important effect on surface gloss, hardness, and resistance to fuzzing upon humidification. The effectiveness of precipitating the resins on the fiber, the amounts used, and the resistance of the resin type to water in the final product will greatly influence moisture properties of the boards. All resins have a certain amount of sizing effectiveness in themselves, but as to whether it is a mechanical covering or impregnation of the fibers or a chemical union uniting with hydroxyl groups in wood is open to arguments. The first small percentage of resin added seems to be most effective in plasticizing the lignin present for greater binding power, but beyond that the results would indicate a further mechanical binding and impregnation of the fiber surface to repel water, as well as filling up capillary voids. Advanced resins as used in the wet process probably cannot be relied upon to form chemical unions with hydroxyl groups for water repellancy, as unpolymerized resins do in the Compreg Process of densifying wood. Perhaps free alkali in the resin may have the detrimental effect that alkalis do on the cellulose structure, causing greater swelling if not well neutralized. Along with this goes the rather questionable practice of adding free alkali to the pulp slurry for pH adjustment prior to resin and size addition. Our company has long discontinued this practice, dispersing at the pH of the pulp as it comes from the refiners.

The effect of other extraneous chemicals that may be added in the slurry cannot be ignored, and foam-killers such as kerosene, pine oil, etc., may well have some influence. In our mill, sodium pentachlorophenate added for termite resistance indicates a certain amount of added water repellancy.

Over all of this hangs the question of how pulp temperature effects the efficiency of chemical addition. Studies have been made with varying results, but our own and certain other data indicate best sizing to be had at temperatures around 100 degrees Fahrenheit.

Densifying and Bonding

The forming process for the pressing mat may contribute some variables influencing water relations. In the Chapman process the re-uses of white water for forming with its resulting additives is one of these. The ability to deposit an even blanket of fiber necessary to control density uniformly is quite important. Most of us are familiar with the warped boards emerging from the humidifier due to lack of uniform absorption from the humid atmosphere. Here, too, the weight of wood deposited will influence the resulting density and care under certain express conditions. The compactness of resiliency of the mat will be a clue to the effectivness of hot-pressing the large shives tending to be quite resilient and fines often compacting to the extent that it is difficult to draw a vacuum on the fiver and adversely effects breathing in the hot press.

One other influencing factor differing in many mills is the application of oils, resins, or sizes to the face of the mat prior to pressing—for caul-release or water repellancy. Excessive use of this practice could lead to breathing difficulties and resulting defects, low density, poor bonding-action of the resin, or panel warping due to uneven facial absorption or insufficient cure.

Highly important is the moisture content of the mat, both as it enters the cold-pressing operation and the hot press. Here, in the wet and semi-dry processes, is determined the need for a screen-back to breath the mat and allow wash-water to escape, this type of surface being another influencing factor in water-absorption results. This washing action on the fivers cannot help but carry away some of the sizing and bonding agents which contribute to the problem. However, the high moisture content in these two processes is the key to the greater ease of compression, high density, and smoothness of the surface and resin flow due to plasticizing action of the steam formed.

In the hot-pressing process are many acknowledged variables influencing the resistance of the final product to moisture, most of which center about the pressure, time-cycles, and heat used. The fiber-plasticizing action of heat, stem, and resin, the flow of resin and size and lignin, all have their interacting results upon the final product. The completeness of cure of the resin, internal temperature reached, with its resulting effect upon the wood chemical structure, density, final moisture content, and smoothness of surface all tend

The pressing and breathing stages used in the three-stage cycle of pressing wet mats, and the hydraulic pressures used are well known for their effect on densifying the board to the point of improved properties, but certain other conditions in the individual press may influence these results as well. Evenness of temperature throughout the platen may be considered important to good results, and smoothness of surface, which is more or less related to water resistance, is always influenced by the condition of the caul plates used. Clean and shiny cauls are essential to a smooth board surface, in addition to allowing more even and complete heat-transfer from platen to board. Need anything be said about the collection of dirt and grime between platen and caul as influencing heating and board-surface.

Screen size may also be an influencing factor in determining the porosity of the back, and surface differences from front to back of wet-pressed boards greatly influence moisture absorption.

It is well known practice in the plastics industry to pre-cool the hot-press prior to ejection of the moulded product. This is done to improve the surface of the product as well as eliminate springback to thicker dimensions upon cooling in air. Seldom is this done in the hardboard industry, but there is another practice that could possibly reduce the reaction of hardboard to humidity or absorption tests.

Treatment Subsequent to Pressing

The treatment of the hardboard subsequent to hot-pressing to reduce its susceptibility to water may take several forms. Heat-treatment or baking without oil in an oven for various lengths of time has the effect of changing the wood chemically and removing water of constitution to reduce the hygroscopicity of the board so treated. In addition, resins are without doubt completely cured to reduce somewhat the spring-back from hot-pressing. The baking conditions are important—including the time, temperature, and velocity of air movement. Our company has for some time been heat-treating all standard board as regular practice at about 265 degrees for three to four hours, depending on the board type. Under adverse conditions of operation this factor shows particular importance in reducing the water absorption. As an example, for a certain run of board, tests on the unbaked boards showed an average of 22½ percent absorption and 14 percent swell, whereas the same run of board with heat-treatment was reduced to 15 percent uptake and 10½ precent swelling. Poorly sized boards have been seen to improve as much as 20 percent in absorption.

Somewhat paralleling the heat-treating process is that of oil tempering hardboard, which is fairly standard practice throughout the industry. This improves the hygroscopicity by the saturating of the board with drying oils which are then heat-polymerized to a solid plastic, forming a varnish-like coating over the surfaces of the board and tending to fill voids and coat the fiber surfaces. Variables here include the completeness of polymerization of the oils, the oil type, the amount absorbed and the amount of solids retained, together with the time, temperature, and circulation. Depth of penetration and full coverage of the fibers are important.

Depending upon the type of oils used, the resistance to water of oil-soaked boards may be poorer than that of standard boards used, unless the polymerization has reached a certain stage. The relative resistance to moisture of the final product will also be influenced by the original board properties.

Sizing or sealing of the surface of hot or cold boards has been tried or contemplated by various companies. If this practice is used, another process is introduced that will have bearing upon the moisture properties of the board treated.

Humidification conditions and completeness are of utmost importance in improving the reaction to moisture of hardboards, as pointed out in other papers on this panel. Wet and dry bulb conditions and length of time of humidifying and board types will determine the final moisture content and resultant hygroscopicity of the product. Type and thickness of board have important influence on this.

Finally, any alteration of the board surfaces in subsequent operations will tend to have some influence for better or for worse upon moisture relations. These may include sanding or planing of the back of screen-side panels, especially in tempered board, which removes the surface film, or the scoring or pressing of decorative surfaces, which may or may not improve the moisture resistance.

Corrosion Experiences with Humidifier Equipment[1]

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Means employed to combat corrosion in humidifier equipment are described.

Introduction

THE HUMIDIFIER in our hardboard plant is one of the first continuous units put into operation. As it was a new piece of equipment with a new process, several problems were encountered. One of the most serious of these was corrosion, which will be discussed in this paper.

Our humidifier was ordered during the first part of the Korean War and it was impossible to obtain stainless steel for certain parts that we felt would be subjected to corrosion. As it turned out, our fears were justified and some parts had to be replaced.

Description of the Humidifier

The accompaning sketch will help to explain the operating principles of our unit.

The air is conditioned to the desired relative humidity by being passed successively through a heating coil, mixed with live steam (from a perforated steam pipe when additional moisture is required) and then passed through a battery of water sprays. A fan blows the hot moisture-laden air down the sides of the unit to a control duct that runs longitudinally between the wickets carrying the boards. The air returns through openings in a false ceiling and repeats its humidifying cycle. The wet and dry bulb thermometers are located on the duct just beyond the fan.

The boards are carried by the wickets in an upright position so that the humidified air passes between them.

The water system for the sprays is a closed system. That is, the water is constantly recirculated from a water tank by a pump to the spray heads. A float switch operates a valve to replace any water lost through evaporation.

Corrosion Experiences

To prevent the corrosion of the various exposed parts, coatings were used. An acid resistant vinyl paint was applied to the walls of the spray tower, and on the wickets and their angle iron supports in the humidifier. An asphalt type of coating, similar to that used for undercoating automobiles, was applied to the inside of the humidifier housing.

The vinyl coating in the spray tower failed after a few months of operation. There is some question as to whether its failure was due to temperature, the acid conditions, or a combination of both.

The vinyl coating used on the wickets started to show failure after several months but the same coating on the wicket supports was and still is in excellent condition. This paradox can be explained if it is assumed that the coating on the wickets was improperly applied. The vinyl coating used requires a careful preparation of the metal surface. The metal must be thoroughly cleaned to insure good adhesion of the paint.

The asphalt coating used on the interior of the housing held up well in some areas, but blistering with evidence of corrosion of the metal beneath occurred in others.

The wickets were repainted. Some of them were coated with a phenolic base paint and some with an epoxy type paint. After three months of operation, both of these coatings are in good condition.

A test panel painted with the same epoxy type coatings was suspended in the spray tower. After a period of approximately two months several blisters occurred.

Uncoated brass and mild steel have corroded badly in the spray tower and a test panel of aluminum showed severe corrosion after several weeks in the same location.

In the humidifier housing, uncoated iron piping has shown slight corrosion. After one year, brass parts have not been affected.

It was apparent that a severe condition existed in our spray tower. A pH study made of the water and vapor at various points revealed the following conditions:

pH of fresh water	6.5
After 5 hours of operation:	
Water in spray tank	3.8
Condensate at fan housing	4.3
Condensate at discharge end of humidifier	4.1
After 9-10 hours of operation:	
Water in storage tank	3.8

Experiments were carried out to neutralize the water in the storage tank. Using a solution of an amorpholine type of amine, the water in the storage tank was maintained at a pH of approximately 7.5. It was also possible to neutralize the acidic material in the steam. However, the amine being carried in the steam vapor was absorbed in the hardboard in the humidifier, causing a yellow discoloration on the surface.

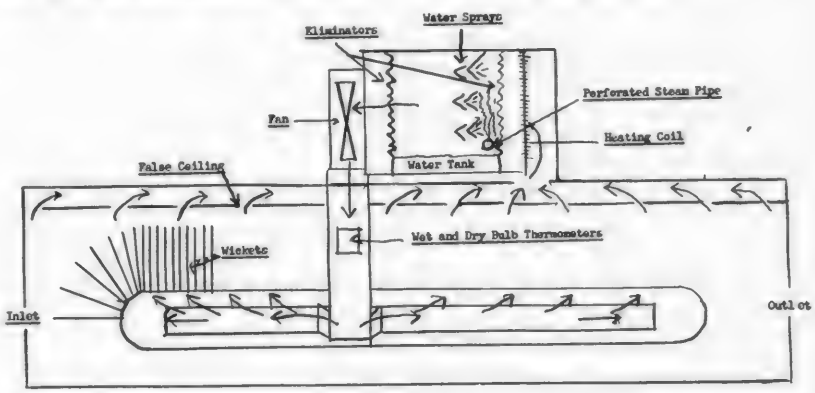
Sodium carbonate, used at a rate of one-half pound/hour maintained a pH above 7.5. However, the acidity of the steam was only affected by one pH unit.

Conclusions

By neutralizing with chemicals, or by maintaining a neutral condition through replacement of the water in the storage tank of the spray tower, the severity of the corrosion in the area should be reduced.

Under these less acidic conditions the vinyl, phenolic, or epoxy coatings tried should hold up well if the temperature does not get too high.

From the results shown so far where these coatings were used inside the humidifier housing, it appears that they will perform satisfactorily under the conditions that exist there.



CIRCULATING SYSTEM of HUMIDIFIER
COOS BAY LUMBER COMPANY

[1] Presented at meeting of the Forest Products Research Society, Hardboard Division, Pacific Northwest Section, February 1, 1954, at Portland, Ore.

The Effect of Operating Variables on Hardboard Values[1]

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The following study was made on a wet process hardboard mill operation in order to determine the optimum conditions for the resin and also what normal fluctuations in board values could be expected in daily production in order that accurate comparisons could be made.

THE STUDY WAS CONDUCTED with the mill being operated at four different conditions. These conditions were:

Run No.	White Water Return, %	Temp. Fiber Slurry, °F	pH, Retention Vat	pH, Forming Vat
I	25	113	6.5	4.7
II	25	120	7.5	5.0
III	0	90	7.9	4.9
IV	0	94	6.3	4.6

Other operating variables such as degree of refinement of the fiber, rate of production per hour, types of board being made and pressing cycle were held as constant as possible. One-quarter inch boards at a specific gravity of 0.950 were pressed for 10½ minutes at 350° F. in all cases.

During the test runs the following observations were taken every thirty minutes.

1. The rpm and amperage of the Asplund and disc defiberators.
2. The temperature of the fiber slurry.
3. The pH of the resin fiber slurry at the retention and forming vats.
4. The steam pressure and temperature at the presses.
5. The modulus of rupture, specific gravity, and twenty-four hour per cent swell and moisture absorption of the test boards removed every thirty minutes from each of two presses. No attempt was made to take the boards from the same press openings. The board selected being that which was being formed at the time the variables were being checked.

Before starting the study, the system was checked and the time of fiber travel through the entire operation determined. The above readings were accordingly taken at predetermined times so that all readings were on the fiber slurry from which the test board was going to be formed.

In determining the modulus of rupture and other board values the selected 4′ x 8′ panels, after humidification, were cut into thirty-two 12″ x 12″ squares. From each of the top four, middle four and bottom four squares one 2″ x 8″ strip was cut for modulus of rupture and one 4″ x 10″ strip for moisture absorptions and per cent swells. The values reported for each panel are the average of these twelve breaks and twelve soak tests.

The average board values and the readings taken on the operating variables for the corresponding board are given in the following tables. These values were analyzed by statistical analysis in order to determine the significant differences due to the various methods of operation, and also the average deviation that could be expected in boards being made under the same conditions (See Table I).

In addition to the average or expected deviations, each basic check value of the boards (specific gravity, modulus of rupture, per cent swell and per cent moisture absorbed) was analyzed by the "Analysis of Variance" as to the effect of combined mill operating condition, press, and load or time of formation. In the analysis no effect of the interaction of loads with the other variables can be made as they were not taken at the same time. The only relationship is the time interval or spacing. Thus any variation or significance related to loads can be only considered as variations between individual panels under one specific condition.

Modulus of Rupture—Table II: The analysis indicates that on the average (80 percent) that:

1. The runs made with 25 per cent white water returned resulted in stronger boards than those made without white water.
2. Where white water was used at the high retention and forming pH, the panels were somewhat stronger than those produced from the run with white water at low pH's.

Per Cent Swell—Table III: The data shows very definitely that the per cent swells of the boards made with white water returned were less than those made without white water.

Also noted was the large variation in per cent swells between panels made under the same conditions.

Per Cent Moisture Absorbed—Table IV: The analysis of this criteria

Table I.—SUMMARY OF RESULTS

Run No.	Asplund RPM	Asplund AMP	Defibrator AMP	pH Retention VAT	pH Former VAT	Temp. °F	M.R.	Swell %	H_2O Abs. %	Sp. Gr.
I	33.7	159	387	6.5	4.7	113	6446	12.05	21.05	0.945
II	32.9	140	416	7.5	5.0	120	6575	11.36	19.05	0.955
III	31.7	129	437	7.9	4.9	90	6368	12.70	20.38	0.950
IV	29.0	130	477	6.3	4.6	94	6322	13.18	23.81	0.951

Table II.—MODULUS OF RUPTURE

Load	I A	I B	II A	II B	III A	III B	IV A	IV B	Mean
1	6248	6953	6791	6558	5982	5952	7135	6235	6
2	6463	6675	6649	6584	5807	5714	6386	6673	6
3	6000	6683	6581	6634	6067	6507	6360	5998	6
4	6318	6875	6378	7620	6057	6948	6012	6250	6
5	5897	7270	6729	6580	6165	6513	6400	6580	6
6	6304	6290	7065	7369	6557	6336	6384	6050	6
7	6601	6388	6387	5171	6426	6332	6829	6220	6
8	6110	5969	6473	6508	7440	6751	6336	6200	6
9	6270	6345	6382	6011	6797	6596	5737	6210	6
10	6188	7059	6737	6292	6098	6308	6385	6069	6
Mean	6240	6651	6617	6533	6340	6396	6396	6248	
Ave.	6446		6575		6368		6322		

[1] Presented at meeting of the Forest Products Research Society, Hardboard Division, Pacific Northwest Section, February 1, 1954, at Portland, Ore.

Table III.—PER CENT SWELL

	I		II		III		IV		
d	A	B	A	B	A	B	A	B	Mean
1	11.92	13.72	11.84	10.59	13.67	11.41	11.85	11.36	12.04
	11.15	13.53	8.75	9.01	12.14	11.82	10.89	12.46	11.22
3	11.59	12.37	9.57	11.88	12.08	12.88	13.33	10.10	11.72
	12.44	11.91	11.22	12.75	12.28	13.63	10.00	10.28	11.81	
	12.71	11.67	12.32	12.69	13.06	14.10	13.70	16.85	13.39
	11.07	10.05	10.32	12.03	12.16	14.62	15.71	12.73	12.34
	12.63	11.15	12.76	10.46	12.00	15.09	15.22	14.72	13.00
	11.30	11.82	11.99	15.88	13.17	16.62	15.36	15.20	13.92
	13.13	11.65	11.01	13.48	10.40	14.30	12.82	12.35	12.39
1	11.94	13.20	9.20	9.55	8.42	10.17	14.55	14.13	11.39
M	11.99	12.11	10.90	11.83	11.94	13.46	13.34	13.02	
A	12.05		11.36		12.70		13.18		

Table IV.—PER CENT WATER ABSORBED

	I		II		III		IV		
d	A	B	A	B	A	B	A	B	Mean
1	20.04	24.32	18.28	18.48	20.07	22.46	18.15	20.53	20.29
2	20.81	21.63	19.99	16.58	20.96	20.44	19.61	23.04	20.38
3	19.59	23.85	18.16	19.33	18.00	22.10	20.20	20.18	20.18
4	20.11	21.76	15.34	20.92	21.40	22.97	21.33	21.93	20.72
5	24.40	20.92	18.28	20.16	19.16	22.80	23.80	27.45	22.12
6	18.94	18.31	16.84	19.01	18.25	21.68	25.10	24.77	20.36
7	18.46	20.81	21.40	19.74	18.90	21.85	23.38	25.89	21.30
8	19.40	20.28	19.66	25.72	20.73	23.82	27.71	31.41	23.59
9	23.69	20.32	17.26	22.09	17.90	22.37	27.38	26.71	22.21
10	20.63	22.71	17.18	16.64	14.40	17.30	23.96	23.67	19.56
Mean	20.61	21.49	18.24	19.87	18.98	21.78	23.06	24.56	
Ave.	21.05		19.05		20.38		23.81		

Table V.—SPECIFIC GRAVITY

	I		II		III		IV		
Load	A	B	A	B	A	B	A	B	Mean
1	0.948	0.903	0.953	0.950	0.911	0.918	0.871	0.932	0.923
2	0.849	0.900	0.919	0.950	0.923	0.934	0.943	0.925	0.918
3	0.949	0.910	0.938	0.942	1.003	0.910	0.931	0.928	0.939
4	0.947	0.936	0.942	0.928	0.937	0.907	0.925	0.944	0.933
5	0.932	0.917	0.948	0.946	0.940	0.918	0.932	0.929	0.933
6	0.942	0.923	0.957	0.917	0.940	0.970	0.935	0.925	0.939
7	0.890	0.959	0.966	0.936	0.946	0.955	0.946	0.924	0.940
8	0.909	0.942	0.955	0.961	0.935	0.940	0.935	0.940	0.940
9	0.941	0.847	0.959	1.002	0.940	0.923	0.995	0.921	0.941
10	0.944	0.852	0.931	0.946	0.960	0.927	0.943	0.940	0.930
Mean	0.925	0.909	0.947	0.948	0.943	0.930	0.936	0.931	
Ave.	0.917		0.947		0.936		0.934		

indicated that the boards with the lowest moisture absorption would be obtained by using white water at the high pH's and those with the highest moisture absorption at low pH's with no white water.

Again there was a considerable random difference between loads within a given set of conditions.

Specific Gravity—Table V: The evidence indicates that the specific gravities of the boards made in run No. I with white water and a low pH were definitely lower than those of boards made in the other test runs.

The correlation of specific gravity with the other three measurable values was checked by grouping the values under nine specific gravity groups. The significance of the regression coefficients calculated from these data was determined. This analysis indicated that in this experiment that the variation in specific gravity in all probability had no effect on the per cent swell or moisture absorbed. With regard to the modulus of rupture there was an indication that the modulus of rupture values decreased 250 psi with every 0.010 decrease in specifiv gravity. However, the statistical test showed that because of the wide variation in individual boards there was essentially no correlation between specific gravity and modulus of rupture.

In addition to the major effects of the four test runs, the data was regrouped and analyzed for the following variables: degree of refinement, retention pH, and forming pH. However, the random variation between panels was so great that any effects were not conclusive. There was an indication that boards formed at low retention and forming pH's had less variation between similar type panels. Also, that greater variation in the per cent swells can be expected from fiber with a high degree of refinement whereas, conversely, boards made from fiber with a low degree of refinement will have greater variations in the per cent moisture absorbed.

Table VI.—2 TIMES THE STANDARD DEVIATIONS

Run	Mod. Rup.	% Swell	% Moist. Abs.
Panels			
I	758	1.66	3.78
II	979	3.52	4.71
III	335	1.90	5.04
IV	1300	4.75	3.59
Ave.	863	2.96	4.28
Means			
I	176	0.42	1.05
II	230	0.84	1.05
III	76	0.87	1.15
IV	337	1.22	0.93
Ave.	253	0.88	1.04

As stated, standard deviations were calculated for not only the means of the four test runs, but also for variations between boards made under the same conditions (See Table VI).

The standard deviation is a measure of the variations of the values from those of the mean or average value. This value is calculated by the equation $\sqrt{\frac{\Sigma (\times - \times)^2}{n-1}}$ where $\times$ is the mean or average value, $\times$ is the measured value, and n is the number of values. With a sufficient number of samples 95 percent of the measured values will fall within the mean value, plus or minus two times the standard deviation.

These values show the wide variation that can exist between individual panels made under similar conditions. According to this study for differences between the averages of various conditions to be significant they must be in the magnitude of 250 psi for modulus of rupture values and one per cent for swells and moisture absorptions.

From the analysis of this data is was concluded that the best operating conditions for this mill would be with 25 percent of the white water returned and retention pH's of 7.0 and forming pH's

Moisture Changes with Different Relative Humidity Conditions in Plant Humidification Equipment[1]

KEITH KRUSE

Forest Fiber Products Company, Forest Grove, Ore.

Describes tests effect of various wet and dry bulb temperatures on the process of humidification of ⅛ and ¼ inch hardboard to obtained desired moisture content.

Purpose

THE OBJECT OF THIS investigation was to check the effect of different relative humidity conditions on the take-up of moisture by hardboard during the humidification cycle. After the pressing cycle, hardboard should be humidified to raise its moisture content to one that would be reached under normal conditions of use. Generally, a moisture content of 5 to 6 percent after humidification is considered to be satisfactory for shipping. Factors controlling the amount of moisture added to the board during the humidification cycle include the length of the cycle and the relative humidity conditions within the humidifier. The rate of circulation is important in obtaining uniform humidification but this is controlled by the design of the humidification system. The length of the humidification cycle depends on the rate of production and in our plant runs approximately four hours for ⅛ in. board and six hours for ¼ in. board. As the length of the humidification cycle is set by the rate of production, the relative humidity condition within the humidifier is the controlling factor in the amount of moisture taken up by the hardboard. For this reason, checks were made on our plant equipment using various relative humidity settings to determine the correct setting needed to obtain the desired moisture take-up by the hardboard.

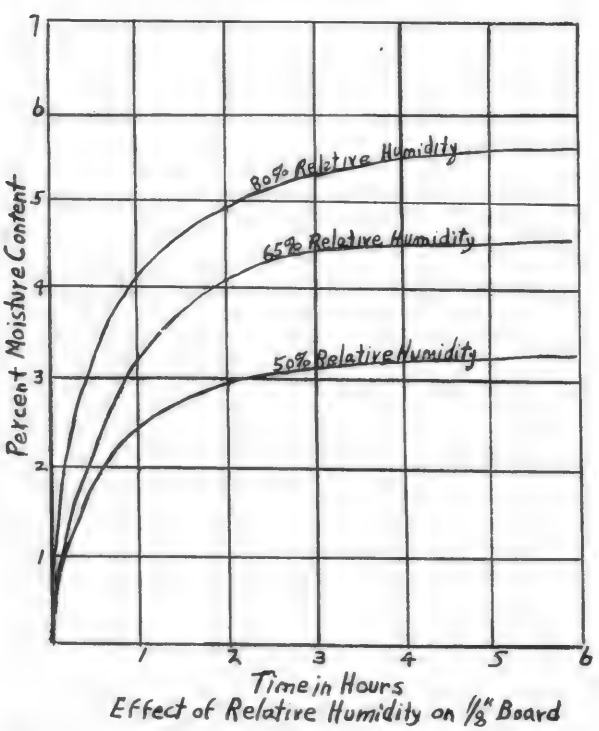
[1] Presented at meeting of the Forest Products Research Society, Hardboard Division, Pacific Northwest Section, February 1, 1954, at Portland, Ore.

Procedure

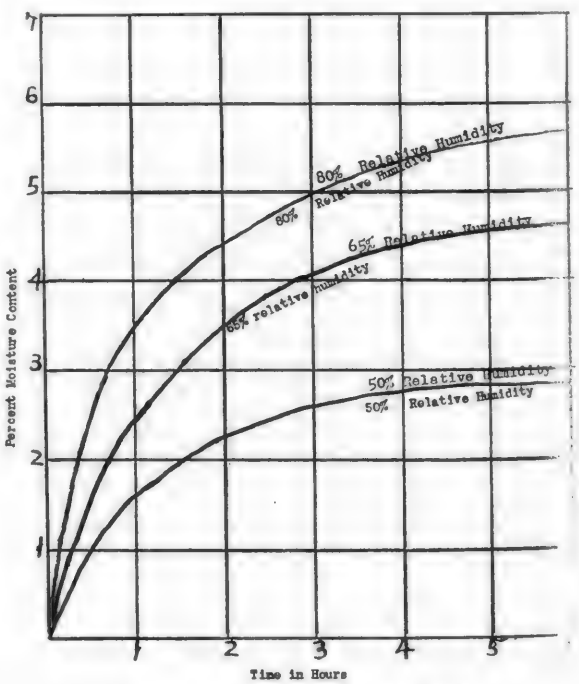
Three relative humidity conditions were used for these trials. A dry bulb setting of 140° F. was used for all conditions and the wet bulb setting was varied to obtain relative humidities of 50, 65, and 80 percent. Oven dried samples of ⅛ in. and ¼ in. board were weighed and placed in the humidifiers. These samples were removed and reweighed every hour during a six hour humidification cycle. From these weights, the moisture contents of the samples were determined for each hour during the humidification cycle. From the data obtained from these trials, graphs (figures 1 and 2) were plotted for each relative humidity condition relating the percent moisture content and the humidification time in hours.

Conclusions

From the figures it is apparent that the board takes up moisture rapidly during the first hour or two of the cycle after which moisture is taken up at a greatly reduced rate. Also, as would be expected, the ⅛ in. board obtains a higher moisture content in a shorter period of time than the ¼ in. board. Examination of the graphs show that to obtain the desired moisture content of from 5 to 6 percent using a humidification cycle of four hours for ⅛ in. board and six hours for ¼ in. board it is necessary to use a wet bulb setting that will give an 80 percent relative humidity condition within the humidification chamber. Changes in the dry bulb temperature over the range that we can control in our plant equipment had little effect on the rate of humidification.



Effect of Relative Humidity on ⅛" Board



Effect of Relative Humidity on 1/4 in. Board

Dimensional Stabilizing Effect of Paper Overlays When Applied to Lumber

BRUCE G. HEEBINK

Engineer, Forest Products Laboratory,[1] Forest Service, U. S. Department of Agriculture

Describes tests to determine effectiveness of paper overlays as a means of reducing dimensional changes in wood. Effects of various thickness and kinds of overlays are compared to each other and to veneer crossbands.

RESIN-IMPREGNATED paper overlays, used heretofore successfully for veneers and plywood, were found to provide considerable restraint to lateral swelling of nominal 1-inch boards from the ovendry to the water-soaked condition. The tests were made on yellow-poplar core stock and white pine lumber of No. 2 Common grade, edge glued to widths of up to 25 inches. The overlay consisted of a 20-mil kraft paper containing 20 percent of a water-soluble phenolic resin, and was glued to the lumber with an acid-catalyzed, room-temperature-setting phenolic-resin glue. A reduction of about 40 percent in lateral swelling was achieved. Since in other tests this overlay has shown high ability to mask knots, pitch pockets, narrow splits, and other characteristics of No. 2 Common white pine, and in addition offers a good painting surface, the product appears well suited for interiors of cabinets, house siding, paneling, and related uses.

Introduction

The U. S. Forest Products Laboratory has repeatedly been called on for consultation on the proper crossbanding of lumber cores in lumber-core plywood, and the many associated problems of warping, cupping, and dimensional stabilization. Much of the misbehavior of crossbanded constructions of this type can be laid to misalinement of the grain in the crossbanding layers, thus raising the question: Can a lumber core be stabilized by some uniform synthetic material whose characteristics are subject to better control than those of veneer crossbanding? Questions of this type cannot be answered unless a standardized means of evaluating the stabilizing effect of various crossbands is established. Early in 1950, therefore, the Forest Products Laboratory made limited tests on a proposed method of evaluation.

The results of these tests on synthetic crossbanding materials, and subsequent exploratory tests on the use of resin-impregnated paper as an overlay on lumber to stabilize its partially in the cross-grain direction, are still limited in scope, but point the way to many interesting applications with further research.

Crossbanding Efficiency Test

Commercially manufactured ¾-inch yellow-poplar core material about 19 inches wide and 3 feet long was cut across the grain into six matched test specimens. The material had a specific gravity of 0.501 based on weight and volume after conditioning at 65 percent relative humidity. One test specimen was selected as the control, and the remaining pieces were overlaid with the materials being tested.

One of the remaining five specimens was overlaid with an exceedingly thick crossband, ⅛-inch yellow birch veneer, with its grain at right angles to the grain of the core. The second was overlaid on each side with five sheets of a commercial urea-resin impregnated overlay sheet, the total thickness of the five sheets after pressing being about 0.070 inch. These sheets as received were coated on one side with a phenolic glue line which formed the bond between the sheets as well as the bond between the assembly of sheets and the core. The panel was hot pressed at about 150 pounds per square inch at a temperature of 275° F.

The third specimen employed a commonly used crossbanded construction, 1/20-inch yellow-poplar veneer, with the grain at right angles to the grain of the core. The fourth was identical to the second, with the exception that only one sheet (approximately 0.013 inch thick) was used on each side.

The fifth specimen was overlaid with a phenolic-impregnated paper sheet approximately 0.046 inch thick that had been obtained from a commercial producer who developed it for experimental crossbanding purposes. It was glued to the core with a room-temperature-setting resorcinol adhesive.

Each test piece, after being conditioned at 65 percent relative humidity, was cut into six individual pieces approximately ¾ inch wide, and trimmed to a length (across the grain of the core) of about 18 inches. By means of a measuring device (fig. 1) consisting essentially of a steel bar having one stationary and one movable tapered point

[1] Maintained at Madison, Wis., in cooperation with the University of Wisconsin.

Figure 1.—Measuring device used to determine swelling of ...ss sections from edge-glued white pine lumber overlaid with ...n-treated paper.

Figure 2.—Knots, splits, other characteristics blemishes of No. 2 Common white pine inch lumber are effectively hidden by resin-treated kraft paper overlay.

(for insertion in the holes) and a sliding dial indicator reading to the nearest 0.001 inch, exact measurements were taken between the holes drilled near each end of the strips. One test strip from each of the six original test pieces was then equilibrated with one of the following conditions:

1. Ovendrying.
2. 30 percent relative humidity at 80° F.
3. 65 percent relative humidity at 80° F.
4. 80 percent relative humidity at 80° F.
5. 90 percent relative humidity at 80° F.
6. Soaking in water at room temperature.

The original length, final length, change in length, and percentage change in length of each piece were recorded. If it is assumed that, for the most severe conditions of exposure, crossbanded material may be expected to change from the ovendry condition to that prevailing in an atmosphere of 90 percent relative humidity, the dimensional stabilizing efficiency of various crossbanding materials can be expressed on a percentage basis using the following formula:

$$\text{Percent efficiency} = \frac{\text{Movement of control} - \text{Movement of crossbanded strip}}{\text{Movement of control}} \times 100$$

Using this basis of comparison, the various assemblies tested had the following stabilizing efficiencies:

Specimen	Efficiency Percent
One sheet 0.013-inch urea-resin-treated paper each side	44.6
One sheet 0.046-inch phenolic-treated paper each side	47.2
1/20-inch yellow-poplar veneer	87.8
Five sheets urea-resin-treated paper (0.070 inch)	88.8
1/6-inch yellow birch veneer	90.6

Results showed that the amount of stabilization produced by one rather thin sheet of resin-impregnated paper was considerable, and that the amount produced by five sheets of the same paper was slightly better than that obtained with the conventional 1/20-inch yellow-poplar veneer crossband. Moreover, the rather heavy, specially compounded synthetic crossband material was only slightly better than the much thinner sheet. This would indicate that there is much to be learned about the proper orientation of fibers, the resin content, and other characteristics of synthetic crossband materials. Even the thick yellow birch crossband did not completely stabilize the construction, probably because of its end shrinking and swelling.

Paper Overlays on Lumber

The somewhat surprising performance of the relatively thin urea-resin-impregnated paper overlay sheet on the yellow-poplar core prompted the question: What performance might be expected of a similar overlay when applied to lumber of lower density such as white pine? It was conjectured that an overlay of this type might achieve three objectives—(1), mask objectionable defects, such as knots, pitch pockets, stain, and small splits; (2), reduce the shrinking and swelling across the grain direction somewhat to make the board more acceptable for certain applications; and (3), reduce the tendency to cup.

Early in 1952 the Forest Products Laboratory started some exploratory work to establish more clearly whether these objectives might be attained. The specific product considered was a wide siding board of low-quality pine overlaid on both sides with a typical resin-impregnated kraft masking sheet 0.020 inch thick. In preparing the overlay sheets 20 percent of a water-dispersible phenolic resin was added at the beater and the resin in the sheet was completely cured before the overlay was applied to the lumber. After a few trials to determine the gluing characteristics of the materials involved, several pieces of nominal 1-inch No. 2 Common white pine approximately 12 inches wide and 8 feet long were overlaid with the treated paper. Lumber with knotholes and wide checks was eliminated along with some of the clear material. The overlay sheets were glued to the base panel (grain of the overlay parallel to the grain of the lumber) with an acid-catalyzed, room-temperature-setting phenolic glue. The gluing operation was done at 100 pounds per square inch and 80° F.

Other tests had shown that this type of an overlay on lumber was capable of hiding completely such defects as sound resinous knots, sound dry knots, spike knots, and checks not over 1/16 inch wide.

Narrow cross sections of this overlaid siding were soaked or ovendried to determine the reduction in dimensional movement as compared to matched pieces without overlays, and also as compared to typical slow-growth, edge-grained redwood siding lumber. The performance of these pieces is given below:

Material	Gain in Width Ovendried to Soaked Percent
Pine controls (flat-grained)	5.94
Overlaid pine (flat-grained)	3.16
Redwood (edge-grained)	1.80

The overlaid pine pieces swelled or shrank about 60 percent as much as the flat-grained pine controls. This is fairly close to the radial shrinkage of white pine, or the shrinkage of edge-grained pine boards in width. The edge-grained redwood shrank considerably less than the overlaid pine; but redwood is one of the most stable native woods.

For many applications, such as wide siding or edge-glued cabinet panels, the reduced dimensional movement of the overlaid pine represents a definite advantage, making for better service. Coupled with the masking ability of the overlay, which makes possible the use of lower-grade material, overlaid material thus makes an attractive product for many uses.

Relation of Restraint to Cupping: In the course of this investigation it was observed that more cupping developed in cross-sectional overlaid strips conditioned from the ovendried to the soaked condition than in matched controls without overlays. This increase in cupping tendency of the overlaid boards was ascribed to the restraint imposed by the overlay material. This restraint, combined with the difference in radial and tangential shrinkage in each board, produces severe shear stresses in the

Figure 3.—No. 2 Common white pine inch lumber can be edge-glued to l e sizes and overlaid with paper for pai d cabinets, built-ins, and the like, as t e 2½- by 8-foot test specimens demonst .

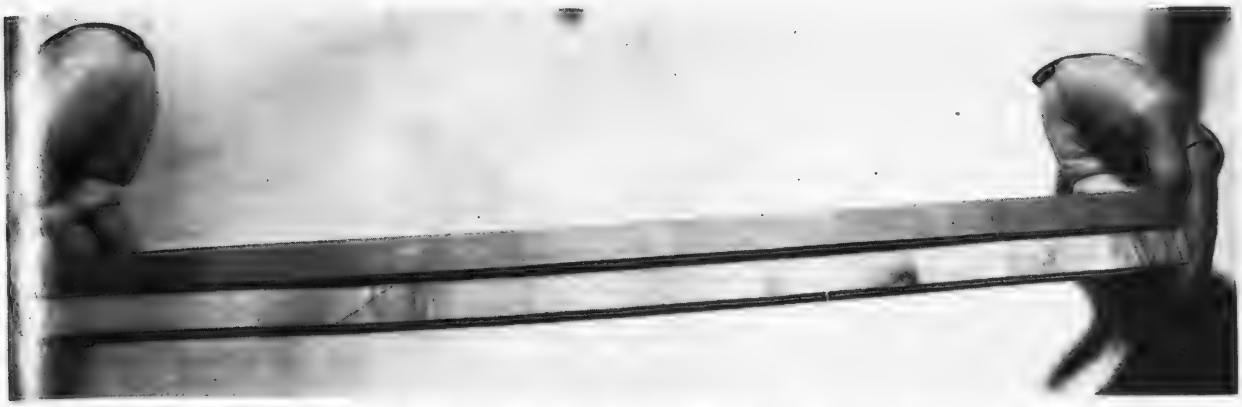


Figure 4.—Across-the-grain swelling on paper-overlaid white pine (upper specimen) is markedly restrained as compared with uncovered wood, these test specimens show. The uncovered control specimen is considerably longer after both were soaked in water.

lumber core and results in additional cupping. The tendency has not, however, been observed on wide overlaid pine siding now undergoing exposure tests outdoors at the Forest Products Laboratory.

To explore this tendency somewhat further, short sections of nominal 1-inch flat-grained pine boards 12 inches wide were overlaid on both sides with resin-impregnated paper overlays that imposed varying amounts of restraint, and one section was overlaid with 0.020-inch aluminum. One matched section without overlay was used as a control. Two narrow strips were cut across the board from each section, one of which was ovendried and the other soaked in water.

When the pieces were measured after conditioning, the tendency to cup was found to have almost a direct relation to the apparent restraint offered by the overlay material. The control and the piece overlaid with thin paper cupped least, and the piece having the aluminum overlay cupped most.

Overlaid Cabinet Panels: To demonstrate the feasibility of an overlay on wide, low-quality, edge-glued lumber for such applications as cabinet interiors, several pieces approximately 25 inches wide and 8 feet long were edge glued of rather narrow pieces of nominal 1-inch No. 2 Common white pine selected to eliminate much of the clear material, but having random grain orientation. To each side of these three pieces a commercial masking sheet, commonly used on Douglas-fir plywood, was glued with a typical room-temperature-setting adhesive at 100 pounds per square inch in a cold press.

Defects similar to those shown in figure 2 were satisfactorily covered and the boards presented a uniformly smooth surface and were flat when reconditioned to 6 percent moisture content (fig. 3). Four ¾-inch-wide strips were cut from each end of each of three boards, and the overlay was removed from two strips of each group by passing them over a jointer. One overlaid and one control strip from each end was ovendried and the matching set soaked in water.

The difference in length between the overlaid and control pieces was then measured and recorded. Figure 4 shows the difference in length between an overlaid and a control strip after soaking in water. Two of the six overlaid pieces submerged in water were found to have ruptures in the overlay, so these measurements were disregarded. A comparison of the measurements of the remaining pieces indicated that the overlaid strips moved about 60 percent as much as the controls (2.80 percent as compared to 4.50 percent), thereby confirming the results of the earlier tests.

Conclusions

Results of the limited tests reported here show that specific combinations of resin-impregnated paper overlays on lumber have attractive dimensional characteristics. Occasional tensile and compression failures of the overlays during soaking and drying indicated that, if wide changes in moisture content are expected, a stronger overlay should be used. Also overlays for species having higher shrinkage and swelling stresses than those of white pine may demand overlays stronger than those normally applied to plywood.

In the work reported here no cyclic exposures, synthesizing severe natural exposure conditions, have been tried. Cycles of this type, or equivalent unprotected outdoor exposure, may point to changes in the formulation of the adhesive bonding the overlay to the lumber core.

Further test work, including applicable variables, will undoubtedly lead to development of optimum combinations, but tests and limited weathering exposures to date strongly indicate the commercial possibilities of overlaid lumber.

F.P.R.S. Book Reviews

Forest Industries of the Philippines, by Winslow L. Gooch, 160 pages illustrated, Manila, May 1953.

This comprehensive and up-to-date report by Mr. Gooch is the result of a year study he made as a Forest Products Utilization Specialist assigned to the project by the U. S. Mutual Security Agency (now the Foreign Operations Administration). The study was made in close cooperation with the Philippine Bureau of Forestry, primarily in connection with a plan to establish a forest products laboratory in the Philippines.

According to the report, the forest cover of the Philippines is one of the most diversified in Southeast Asia. The forests contain over 2000 species of trees that attain a diameter of 1 foot or more, but the wood-working qualities are commercially known for less than 200 species. Most of the forest tree species are tropical evergreen hardwoods, mainly of the dipterocarp group but there are extensive areas of pure pine in the Mountain Province of Luzon.

The Bureau of Forestry estimates the classified ground surface in the Philippines as shown in Table 1. The total volume of merchantable standing timber is estimated at about 447 billion board feet.

Less than 3 percent of the forest lands of the Philippines are privately

Table 1.—APPROXIMATE CLASSIFICATION OF GROUND SURFACE OF THE PHILIPPINE ISLANDS

Ground Surface	Percent	Estimated Area		
		Hectares	Square miles	Acres
Commercial forest	38.38	11,415,020	44,056	28,206,514
Noncommercial forest	15.00	4,459,920	17,213	11,020,462
Cultivated land	27.50	8,179,992	31,571	20,212,760
Cogon and open land	17.06	5,073,300	19,580	12,536,124
Swamp	2.06	612,740	2,365	1,514,080
Total	100.00	29,740,972	114,785	73,489,940

owned. The rest belong to the Government and are administered by the Bureau of Forestry. The forest lands are now being reclassified to eliminate those suitable for agricultural use and settlement but it is expected that from 45 to 50 percent of the toal land area or abou 35 million acres will remain after the agricultural lands have been eliminated. This will consist of forest, grazing, swamp and open waste land. Under the forest laws of the country, private operators can obtain leases for taking logs or other forest products from government forests under Bureau of Forestry cutting regulations. Payment is made at fixed prices per unit of material removed. Citizens both of the Philippines and the United States are eligible to acquire timber cutting rights.

During the Japanese occupation there was much uncontrolled destruction of forests to supply the needs of the Japanese military forces and illegal clearing and burning of forest land for agricultural purposes. Fires destroyed many young forest plantations. The retreating military forces also destroyed large quantities of logging and sawmill machinery. Timber destruction has been greatly reduced but not entirely controlled since the postwar rehabilitation of the Forestry Division. Adequate supervision and maintenance will come with increased appropriations which will, at the same time, increase the financial yield to the government through increased timber sale receipts. Exploitation of logs today amounts to about 1 billion board feet per year which, if judiciously distributed, could be doubled without overcutting. These figures take no account of the large annual loss of timber through pilferage and illegal land clearing.

Lumbering is one of the five major industries of the country. In addition to supplying domestic needs, the country expected to export 80 million board feet of lumber and 290 million board feet of logs in 1952–53. A high percentage of the logs were shipped to Japan and of the lumber to the United States. The export business was heavily influenced by the war in Korea and changes are to be expected with cessation of the fighting there.

The Food and Agriculture Organization of the United Nations sponsored a six-months training school in mechanical logging at the Philippines College of Forestry at Los Banos, during the period October 1952 to March 1953. The training school was attended by about 40 trainees representing forestry departments and timber companies from 11 Southeast Asian Countries.

Lumber in the Philippines is generally seasoned by air drying 30 to 90 days which will reduce the moisture content to about 30 to 40 percent. Although there are not enough dry kilns in the country, some lumber is kiln dried to a moisture content of 15 to 18 percent for furniture, doors, casings, window woodwork, and flooring. Since the average humidity throughout the year is around 80 to 90 percent, drying to lower moisture contents is not necessary.

The Gooch report gives information, statistics and illustrations on the principal wood industries of the Philippines and lists the major plants engaged in them. Included are logging, lumber manufacture, veneer and plywood production, furniture, fiberboard, pulp and paper, wood preservation, musical instruments, toys, cigar boxes, wood carving and turnery, wood airplane propellers, firewood and charcoal, and home industries. Secondary forest products are also discussed, including bamboo products, rattan and other fibrous plant products, barks, tree resins, gums and saps, and various others.

The report also gives a brief history of the Philippine Bureau of Forestry from the early Spanish regime to the present, discusses the present organizations and problems of the Bureau, the new forest products laboratory, and the College of Forestry of the University of the Philippines. Another section gives information useful to applicants for forest cutting licenses, discusses the care of logs to avoid insect and other damage and gives the Revised Grading Rules for Logs in effect since March 5, 1952.

Anyone interested in the forests or the forest products of the Philippines from either the research or the business point of view will find much of value in this report.

Strength Grading Rules for Finnish Structural Sawn Timber, by Prof. F. E. Siimes, Publication No. 9[illegible], The State Institute for Technical Research, Lönnrotinkatu 37, Helsinki, Finland, December 1952, 35 pages, 27 figures. Original in Finnish, but available also in 28-page English translation. Price $2.00 for English Edition including figures and illustrations.

"Strength Grading Rules" is perhaps the most important recent research publication to come from the Wood Technical Laboratory at Finland's State Institute for Technical Research. It contains the official grading rules and allowable working stresses for Finnish pine and spruce.

Allowable working stresses for the use of engineers and architects are given for three strength grades (I to III) referred to as T–130, T–100 and T–70 where the number denotes the permissible bending stress in kg. and the letter T is the mark of stress graded lumber. Tables are also included giving permissible defects and properties of the three strength grades.

These grading rules summarize test results and experience gained during many years of research and are based on extensive tests of structural size timbers ranging from 2″ x 4″ to 3″ x 11″, nominal. Excellent definitions of terms, well illustrated, are given for properties and defects of sawn timber. Methods of measurement are defined and shown in descriptive figures to eliminate confusing alternatives.

Modified grading instructions, which have been made in collaboration with Swedish timber experts, are given in the appendix for export timber. Typical strength marks are proposed and complete instructions set forth for placing identification stamps on each piece of lumber.

Practical recommendations are given for marking, producing, and using strength-graded timber. The publication proposes limiting production to seven nominal sizes: 1½″ x 5″, 2″ x 5″, 2″ x 6″, 2″ x 7″, 2½″ x 7″, 3″ x 8″, and 3″ x 9″. This small number of commercial sizes will simplify grading, minimize inventory to be stocked by retailers, and encourage the widespread use of strength-graded lumber.

(Reviewed by L. W. Crandall, Fulbright Research Scholar, Helsinki.)

The Influence of Flush Door Design on Door Plant Layout

R. B. FULTON

Chief Industrial Engineer, M and M Wood Working Company, Portland, Oregon

It is pointed why a door plant layout must be fitted to the type of door design being manufactured, and also that each door plant must be treated as a unique problem in regard materials, costs and products.

THE WIDELY VARYING construction designs used in manufacturing flush doors call for equally wide variations in plant layout and relaxed manufacturing processes. Construction designs are necessarily tailored to customer requirements, material availability, equipment and facilities and the like. These, in turn, set up the layout specifications.

Test Characteristics

The design of a door should be directed toward the attainment of certain definite physical characteristics, subject to determination by test, which will insure giving—within the range of reasonable cost—satisfactory service to the customer. Common tests which are used to set up design objectives are: exposure to severe and alternating temperature and humidity differences on each door face, racking to determine stability in the plane of the door, water cyclic tests to check glue bond, and the like.

Similarity with Plywood

Flush door operations are quite similar to plywood with the added complication that the center core may be built up in a great many different ways. The variation in constructions is endless, with each separate door plant utilizing those which are particularly fitted to its own needs. However, the operations of spreading, pressing, processing the face and cross-banding veneers, sizing and patching the doors are closely akin if not identical with parallel plywood operations.

The variation in constructions and detailed specifications is quite large even within one plant; also some of the variances would have no effect on plant layout. The detailed presentation of specifications and related technicalities is beyond the scope of an industrial engineering study for layout purposes but, in the following, some construction generalities are brought out.

Constructions

Flush doors may be made either with solid cores or hollow core. The solid core type is usually used for outside entrances while the hollow core may be used either on the exterior or interior. Normally, exterior door openings are designed for doors 1¾" in thickness. Interior door openings usually require 1⅜" doors. Both solid and hollow core doors may be either 5 or 7 ply, and hardboard faced doors may be 3 ply.

Solid Cores: Some typical solid core constructions are shown in exhibit A; however there are at least twenty more that are common.

The construction of examples 1 and 2 are somewhat similar to panel doors. The stiles are grooved on the sticker and the rails are tenoned to fit into the groove. In example 2 the rails would also be grooved to receive the tenons of the vertical mutts.

In example 3, the center of the core is built of short lengths of varying widths and lengths and can be worked up by edge gluing on the Plycor or high-frequency machines.

Hollow Cores: The variety of constructions for hollow cores is tremendous. With respect to material only, the component members may be chemically treated paper, wood, or a combination of both. The paper, of course, is used as filler material between wood stiles and top, bottom, and cross rails. It is resin-impregnated and after being expanded mechanically is set up by the application of heat to give a certain degree of stiffness. Some common varieties are similar to a honey comb when expanded, others form a lattice effect.

There is also a bewildering array of hollow core constructions using wooden or plywood strips. Some examples are shown in exhibit B.

The method of laying up the door at the spreader and the handling of the core up to the spreader determine to some extent the core construction. A sturdy core is needed, for example, if the core is to be passed through the spreader rods.

Stiles and Rails: In either the hollow core or solid core door the stile may be one piece or may consist of an edge strip backed up by a filler strip made of short pieces of wood or plywood glued by high-frequency or Plycor methods. Rails also may be one piece or be built up of wood blocks or pieces of plywood.

Cross Banding: The requirement of door cross banding is very similar to that for plywood with the important exception that core gaps must be held to an absolute minimum since the door edge is exposed to view when installed. Depending on the type of face and core the cross banding may be laid across the width or length of the door. Since a door with wood faces normally has the grain running vertically the cross banding commonly is laid across the length of the door. In good door construction the plies should be crossed as in plywood. One piece edge glued cross banding is available on the market and is sometimes used. This has the advantage of absolutely preventing any core gaps.

Faces: Besides wood the door faces may be made of aluminum or steel sheet or Masonite or similar materials. Common wood species used for door faces are birch, gum, lauan, and, of course, rotary cut and vertical grain Douglas fir.

It is convenient to design the door so that the number of different thicknesses of outer core and cross banding is a minimum. The thickness of face veneer obtainable on the open market varies from 1/7 to 1/28 inch. If the faces should be obtained in, say 1/16 and 1/20 inch only, then only two thicknesses of cross banding and one thickness of center core is needed for a 1⅜" door, for example. Such standardization of thicknesses greatly facilitates the manufacturing process by reducing the number of separate items going into the doors.

Although there is no universal agreement on venting, its practice appears to have considerable merit in permitting steam generated from the glue and warm air within the door to escape during pressing. Also, air in the door is always at atmospheric pressure and cupping and bulging due to air pressure are eliminated. For this reason various parts of the core are grooved to permit easy access of air.

Plant Layout

Normally a door plant obtains its materials from other woodworking

Presented at meeting of the Forest Products Research Society, Pacific Northwest Section, February 1, 1954, at Portland, Ore.

EXHIBIT A - SOLID CORES

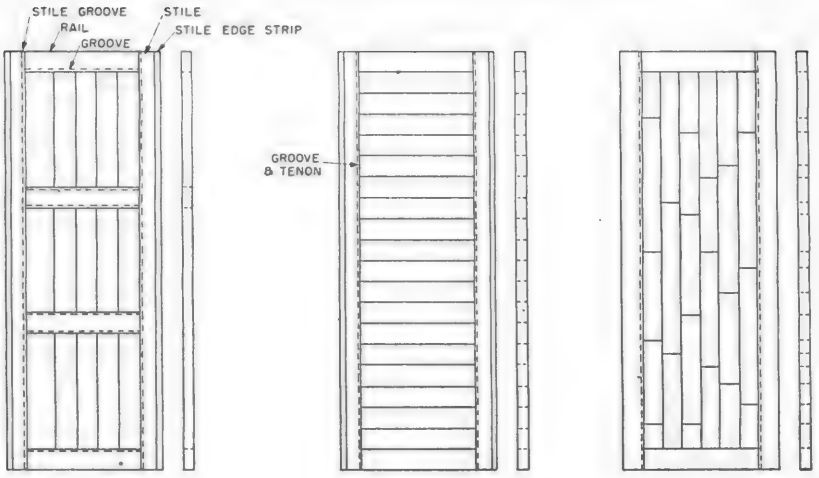
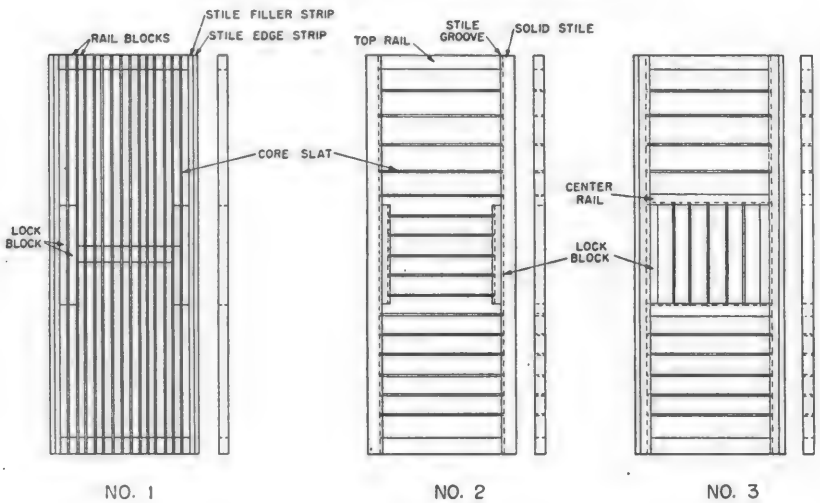


EXHIBIT B - HOLLOW CORES



plants such as sawmills and plywood or veneer plants. Lumber stock if received green must first of all be dried. After this come the cutting, planing, and other dimensioning operations. Where the stiles are to be built up from short pieces they are passed through a Taylor Clamp or Plycore machine. Good plant layout would normally require that these operations be grouped together. The stickers and double-end tenoners for the final preparation of stiles and rails would normally be placed near by. Wood strips, if used, would be trimmed to length in the first operation. If the interlocking strip construction is used, it is necessary to cut the slots on a gang dado head. Plywood strips must, of course, be cut to proper width and length. Lock blocks and spacer blocks would also be produced in this department by means of gang saws and stickers.

The preparation of cross banding can be handled as a separate entity and usually involves only the necessary patching to bring the stock up to grade and cutting it to length.

With respect to face veneers, they may be purchased as skins, in which case no processing is needed; or, if purchased in flitches, the regular operation of dry clipping, jointing and taping are involved. In this connection, the use of tapeless splicers has become more widespread in recent years.

The next separate operation is the assembly of the component parts of the center core. For hollow core doors the assembly process varies according to whether or not the core is passed through the spreader rolls and according to intermediate handling prior to spreading. Some plants assemble only the stiles, rails, and lock blocks, the strips, lattice-work, or paper honeycomb being laid in at the spreaders. Common methods of holding the core together include staples, tape, and groove and tenon joints. The assembly of solid cores is very similar to the door driving of panel doors. These cores must be sanded or surfaced before using.

Several different methods of laying-up are used at the spreaders. For five-ply hollow and solid cores the cross banding is passed through the spreader rolls. Seven-ply doors consisting of two three-ply skins on either side of the center core are laid up differently. For solid cores the skins (faces), placed back to back, are spread. For hollow cores either the core or the skins may be spread. The advantage of spreading the core is the much lower glue consumption; however, a sturdy core construction is necessary to withstand the handling involved in passing through the rolls.

Hollow core doors are pressed at 100 to 125 psi on the hot press, while 150 psi is used for solid cores. Temperatures are approximately 270° F. Much lower pressures are indicated for paper honeycomb core. Cold press pressures range from 100 psi for hollow core to 1[illegible] psi for solid core.

In order to avoid excessive pressure on the strips in the core some plants have developed a system of counter weights for the press platens. The hot press curing time for solid core doors is considerably longer than for hollow core and the distribution of orders as to solid and hollow core affects press production, the spreader-press relationship, and, in turn, the plant layout.

From the press the doors pass to the sizer which trims them to size and then to the sanders. These operations are usually done in close conjunction with each other.

The final operations before warehousing and packaging are grading, patching, and belt sanding, and these also are conveniently grouped together. Stroke rather than drum or belt sanders may be used for the final thickness sizing and surface finishing.

Glues

Urea resin glue may be used on the hot press or on the cold press. Clamping would be required on the cold press. No-clamp glues include protein and blood albumen. Hot press glues include, besides urea resin, melamine, phenol, and resorcinol glues. The location of the loft with respect to the spreader is important. This distance should be as short as possible in order to minimize time loss in working the line.

As in any industrial operation the handling of material is of vital importance in door plant layout. Full use

should be made of lifts, roll cases, industrial trucks, hoists, wherever possible.

Detail Work

The amount of detail work performed would affect plant layout by presenting special requirements as to machinery and floor space. Such detail work consists of special lights, grooves, inlays, and the like. In some cases the detail work may be very elaborate, involving for instance mosaic inlays and hand carvings, so that special care and processing is required throughout the manufacturing.

Summary

It has only been possible in this report to touch very briefly on door design and plant layout. However, the point should be well established that the design or construction definitely determines the layout and also that each door plant has its own unique position with respect to materials, costs, and products and, therefore, requires a special layout fitted to these conditions for it to function most effectively.

How Filmwood Fits into the Wood Industry Picture

EDWARD COLEMAN
Filmwood Co., Chicago, Ill.

Describes product under consideration and emphasizes how it permits good design to be employed in the mass furniture field.

THE DEVELOPMENT of the design industry in recent years has been an important factor in many of the phenomenal sales histories of industry. Today's designers have available scores of new and traditional materials. Recent years, particularly the years since the war, have proven how effectively designers have made use of these materials.

Of the available materials probably there are none that surpass the beauty and friendliness of wood. Long before designing became an industry fine woods were used to add luxury to fine homes. The luxury woods are, of course, those that are highly selected for character of figure, such as swirls, crotches, butts, stumps, burls, etc. Fine furniture has consistently utilized the beauty of fine figured woods for centuries.

In the manufacture of custom furniture it is desirable to have highly selected wood patterns. It is not particularly important to have large quantities of the same pattern for custom furniture. In the manufacture of production furniture, however, it is of extreme importance that the same consistency of figure and color be held throughout the line.

The designer naturally desires that each reproduction of his furniture designs have equal beauty. This is not always possible with ordinary veneers. Now if the designer is to be allowed to follow his desire to build beauty and permeability into his furniture he must resort to a stable material that will not change in physical or optical values. Today, designers have worked very hard to improve the buying taste of the American consumer. The designers that have worked too religiously to improve designs can hardly be expected to accept run of the mill veneers that would jeopardize the full balance of designs.

Many cabinets are designed in such a way that only Filmwood can maintain the balance and beauty of character desired. (Figured woods vary from one flitch to another and within the flitch itself). When Filmwood is used there is no worry about whether or not the pattern will lean one way or another because of variance of veneer character. Conceive, if you can, a picture of a perfectly balanced tree. When you see this tree its beauty strikes you at once. Should the symmetry of this tree be spoiled the value of the picture is lost. The designer visualizes certain selected fancy veneers as I would the tree. As soon as the pattern is off centre the picture is spoiled. Certainly, the designer would not attempt to use regular veneers where he uses Filmwood.

Supply and demand of selected figured wood patterns became unbalanced when the electronics industry went into full scale production after the war. Designers and manufacturers have turned to Filmwood veneers to satisfy a consumer demand for beauty.

Filmwood veneers are full color authentic reproductions of the finest woods available. The library of fine veneered panels that Filmwood has collected make available for the furniture manufacturers an array of patterns and finishes previously impossible.

The public has become accustomed to seeing beautiful, figured furniture and no longer feels that finely finished furniture must be limited to the wealthy.

The figured and inlaid woods are generally difficult to use because of their tendency to crack and check along the stress lines. Many figured veneers prior to finishing have to have voids burned in or be filled with special crack fillers, such as where the figured veneer has fallen out in cutting or where the tree has had a defective growth. Filmwood eliminates the costly and tedious work of treating the defective areas.

Filmwood incorporates any type of design whether it be swirls, crotches, inlays or marquetry or borders. If the original panel has 5 colors or 6 colors or even more, each color is recorded photographically and reproduced color for color in the Filmwood film. During the photographic process defects in the original panel can be modified or eliminated. All of the desirable detail and character can be retained.

Filmwood is laminated by low pressure laminating equipment either rented or sold by Filmwood. A solvent method of application is generally employed that welds the Filmwood and other subsequent finishing operations into one integral film of lacquer. Crotches, swirls, and other patterns are laminated to veneered panels or other suitable surfaces. Usually flat cut mahogany is used for the base of the fine mahogany reproductions. Walnut figured grains are usually laminated to the less expensive walnut veneers. Filmwood does not eliminate any wood or veneer inasmuch as there is no structural value to the film itself. The thickness is approximately ¼ of 1/1000 of an inch thick. This very thin film is laminated to the panels and top coat lacquer is applied. Normal finishing methods are employed in conjunction with Filmwood. The finished products have warmth and

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beauty that is certainly appealing to the consumer.

Many of you are familiar with the involved finished procedure required for panels laid up with multi-colored veneers. If the lighter woods are to retain their light tones, they must be shellacked or masked to protect them from the filler and stains that are normal finishing operations.

Toners are often used to equalize colors of variegated panels. Burning in and plugging is employed to fill in voids of ordinary fancy woods. Filmwood, because it is applied over stable panels that are clear and smooth, elimiantes masking and shellacking of multi-color veneers. Because Filmwood is controlled color film, there is no need for toning to control color. Obviously, burning and plugging is not needed since the surface was selected because it was smooth to begin with.

Modern design has increased the importance of color and character of furniture. Filmwood has given the designer, the manufacturer, and the retailer the assurance that there will no longer need be field rejects because the customer has retained the mental image of the furniture displayed.

Many retailers have had merchandise returned because the color or character of the unit delivered from stock did not coincide with the floor samples shown at the time of sale. Furniture finished with Filmwood veneers will not vary in pattern and color can be controlled as desired.

Filmwood adds prestige and grace to furniture and affects an economy to the manufacturer and gives the consumer high quality merchandise. Filmwood does not really compete with ordinary wood, it merely enhances it's value. Filmwood has created a demand for fine figured woods where a market before did not exist.

Inasmuch as Filmwood's business is the manufacture of custom reproductions, it has led us into other fields related to Filmwood. We are currently producing material known as Flintwood. This is a high pressure laminate that is a photographic reproduction of wood or other patterns or combinations of many varieties of patterns. It is a melamine surfaced laminate, alcohol proof, cigarette resistant, scratch resistant, and comparable to any of the well known high pressure laminates. It is, however, a very highly specialized type of laminate, and is made only to custom design. The design is limited only by the concepts of the designer.

The third material that Flintwood produces is known as Film Transfer. This is a stock item, produced only in the simpler patterns. It is a cast film that is either clear or incorporates a photographic reproduction of wood or other patterns. It is put on smooth surfaced materials, such as plywood, metal, glass or wall board type materials. It requires no prefinishing of the panel and no finish is required over the top of it. The panel must be sanded smooth and be free from holes. The material is alcohol proof and scratch resistant. It surpasses the average present day finish. The first application machine on this process has been delivered.

Discussion

C. H. Beiger (Sears-Roebuck Company): You say that by spending more money it is possible to get best finish by printing. How do prices compare?

Mr. Clark: The question is wrapped up in how big the runs will be. If production requirements are big, the printing can give best finish and savings. For example, where production was limited by finish method to 600 or 800 panels, the company went to printing and could turn out 1,200 panels per day, using hardboard, grained material.

Mr. Coleman (Filmwood): Plates are harder to set up for small runs. Films are easier to use in small quantities.

(?): Can finishing materials costs be cut?

Mr. Clark: No. Such prices have lagged behind in recent years, and only in the last few months have reached point to make profits for finishing materials manufacturers compatible to those made by similar industries.

Joe Allegretti: Much basic work needs to be done on the whole finishing problem—such as Jayne's work in the September FPRS Journal on finish defects arising from defects in veneer. It's a real problem to reduce finishing costs.

Mr. Clark: Prices can't be expected to be reduced much, but such developments as hot spraying, saturating and atomizing may help save excess waste in application of finishing materials.

Mr. Coleman: One thing about the use of Filmwood, you know definitely your material costs, as you buy by the sheet and use by the sheet.

Graining as an Aid to Competition

P. M. CLARK
Finishes Division, Interchemical Corp.

Author describes how inks and surface coatings can be used to simulate wood on practically all other kinds of construction material. Processes are described briefly.

THE COMPLIMENT TO WOOD repeatedly given by the metal and plastic industries, when they seek to reproduce grains on non-wooden surfaces, is truly deserved. Nature is a great artist in her wood grains even if only in a small percentage of cases. The buyers desire for beautiful wood grain patterns has been fostered by many generations of clever woodworkers, to the point where it is a part of our life. Marbles and leather grains are specialty items having much narrower usage than wood grains.

My company, the Interchemical Corporation, is primarily a producer of inks and surface coatings of all kinds. What competition to Forest Products material is being aided by our inks and surface coatings which protect the inks?

A consumer is frequently attracted to an item of furniture or an appearance having at least the appearance of a figured wood, although he can in many cases buy a solid wood, or veneer of. Competitively speaking, through the art of graining (actually printing) almost any other material of construction can be made to simulate these figures. This includes metals such as steel, alminum, magnesium, etc. It includes rigid and flexible plastics from many groups including bakelite, polystyrene, vinyl resins, polyester resins, natural and synthetic rubbers, etc. It includes ceramics, tile and synthetic stone.

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Each of these materials when classed as a constructional material has physical properties justifying its use. The outstandingly spectacular fields include the elimination of all wood from the construction of the great ocean liners and from aircraft because of the flammability of wood and hardboard. The transition from all wooden ships to woodless ships has occurred within a very few generations. Now plastics are fighting hard for the pleasure boat field. Grain printing can help these plastic boats to look like wood and make them more like boats people are accustomed to.

Wood has been forced from the automotive field for structural strength reasons but grain printing on the interior panelling has been immensely popular for many years. The current styling is away from wood grain printing on dash and door panels but it will come back again.

It must be very encouraging to the hardwood men to see the gallant comeback of the birch kitchen cabinets just when the steel cabinets had apparently swept the county. A potential competitor is the wood graining to stimulate birch on metal of plastic, including the newer polyeste laminates.

Wood or hardboard has no sensible use in stoves, oil heaters, portable electric heaters or furnaces, but a surprising number have been wood grained (some rather poorly) in the past. Currrent trends are toward wrinkle finishes and opalescent finishes.

Graining has and will continue to help metal and plastics in the field of office furniture such as cabinets, desks, filing cabinets, chairs and tables. The utilitarian grays and greens look too monastic for many. Wood effects are still appreciated and it is expected the wood grained hardboards will work with veneers to keep a large part of office furniture in the Forest Products group but not without strong competition.

Wood grained metallic or plastic venetian blinds and valances provide a serious threat. Wood grained office partitions such as those of E. F. Hauserman are established competitors for wood partitions.

Wood grained polyester and melamine table tops and wood grained hardboard tops are engaged in battle today for the card table and occasional table market.

Many thousand potential wooden radio and television cabinets have been displaced by plastic or metal grain printed to simulate wood.

Thus far I have talked about the attempts of the stylists and designers to introduce substitutes for Forest Products by surface printing to simulate the beautiful natural wood grains. This has resulted in the loss of many markets to the Forest Products industry. Now I would like to talk about wood and its competitors when the surfaces are to be styled with other reproductions such as marbles, leathers, fabrics, ceramics, and all of the great multitude of art compositions.

Metals, plastics and composition boards, as the result of their manufacture, normally provide excellent surfaces for printing operations, but woods and veneers must be sanded and surfaced before they can receive equally fine screen printing. The hardboards such as Masonite can compete directly in this respect. There is a strong trend at the moment towards special designs on tiles and wall panelling and if the buying power continues to disappear, greater pressure will be put on the designers to produce manufactured goods appealing to the public more than those of his competitor. The white, sanitary looking kitchen may become very unpopular. There are signs of this, partly as a result of manufacturers striving for a greater percentage of the available markets. If, pastel refrigerators, colored stoves and birch cabinets invade the kitchen, some queer color combinations will result.

Aluminum exterior siding is taking small bites in its field. Surface printed metal panelling is a threat to interior panelling. Here differences in flammability can make advertising copy.

Gypsum board wood grained or surface printed with a variety of designs, can be set up as a serious competitor for plywood and hardboard.

While a number of competitive situations have been outlined, they represent only a part of the picture. Rather than extend the list I would like to talk about the graining process (or printing) and the necessity of protecting the printed design. The quality of the printing is dependent upon two main factors. (1) The engraved roll or plate to be used in the printing. (2) The smoothness and general printability of the surface.

There is little gain in using the delicately engraved plate or roll on a rough surface and conversely poor results will be obtained by using a coarse, poorly engraved roll on a smooth surfaces. Therefore, the manufacturers of the engraved roll, the formulators of the ground coats, graining inks and protective coatings must work closely with the manufacturers of the items to be coated in order to get adequate results. The hardboard manufacturers have progressed a long way along the line of producing surfaces on which finely textured engraved rolls can be used. The fineness of the engraving is controlled by the particular Benday screen used in the photographic reproduction process. In effect this controls the number of dots per square inch which are printed to produce the design in question. The depth of the etching controls the amount of ink applied to the surface for each of these dots and the variation in the depth of etching gives the color gradations which when tinted produce the desired design.

Normally in the lithographic wood grain production as exemplified by the decalcomanias several colors are printed independently to give the overall effect. The direct production of grains or other designs on wood, hardboard or metal surfaces gets the total color effect from one colored ground coat plus one printed ink coat. A few manufacturers have gone so far as to use a second printed ink coat and this leads to a superior reproduction with greater apparent depth and color contrast. Another means adopted is to spot or area shade the ground coat with a spray gun prior to the printing with the single ink color. This gives interesting results but for the very highest quality of grain reproduction the manufacturer must consider the effects given by using two or more ink applications. Interchemical long ago found it wise to produce engraved rolls and plates and by virtue of many years manufacturing experience, we are very proud of the quality of these. We have also worked for many years with the Hammant Tool Company of Dayton. Ohio, and there are now available both vertical and horizontal graining machines which should be examined by the prospective users. The combination of the adequately engraved roll or plate and the graining machine is an important part. The quality of the ground coats and the graining inks and their relation to the particular engraved rolls or plates have been studied so that there are complete finishing systems for graining including the protective topcoats for almost any present usage.

Wood Can Meet Competition Through Better Finishes

MUIR ROGERS
Vice-President, American Marietta Co., Chicago

It is noted that the finishing industry is presently a low profit industry; therefore price reductions cannot be expected. The alternative, as a means to meeting competition, is to develop finishing systems which will save coats and application costs.

THE FINISHING INDUSTRY has always been thought of as a high profit businesss, probably a throwback to the early days. Today, this is not true and any finish supplier who gives the service required, does the necessary research, and is competitive in price, finds himself continually struggling to make a satisfactory margin of profit in keeping with profits of other industries.

Today, the public is much more conscious of defects in finish than ever before. In the old days, water spotting, easy scratching, cold checking, crazing, discoloration, etc. of furniture were usually attributed to carelessness on the part of the owner or the natural result of age. Now the customer insists that the finish be good and that it hold up, or else he insists on restitution.

This means that the hit and miss method of making finishing material are gone. The days of the old type finisher who insisted on adding a pinch of this or that to the finishing material because he then had a secret formula, are also gone. Today, with the necessity of quantity production in manufacturers' plants, where conveyors, ovens and other time and labor saving devices are being used, the finishes must be tailored to each set up. The slightest disruption may cause a complete shutdown.

All this means that the finishing supplier must have a much larger staff than ever before. His controls must be as tight as possible, his laboratory staff must be much larger and a considerable staff of service men must be ready to be in a customers' plant at a moment's notice. All this, plus new development work which is going on all the time, is costly, but certainly necessary to do the job expected by the modern day wood or metal manufacturer.

I am bringing up these facts to explain why the finishing suppliers cannot lower prices on materials now being used in order to help the wood industry compete with substitutes. The only other alternatives to devise systems which will save coats and application costs.

As regards television cabinets, American–Marietta's first step in this direction was a flow coat system that eliminated rubbing. This has already been used on thousands of television cabinets. Our next step, the latest, is a two-coat system, the details of which I am not in a position to divulge until our regular customers have taken advantage of it. All I can say is that it is a two-coat application only, as compared to the regular stain, wash coat, sand, filler, wipe, sealer, sand, lacquer first coat, lacquer second coat —or eight operations, including six finish coats.

We now have ready for the market a new type filler that has the advantages of easier wiping, sharper color and no puff under top coats. It also gives much better adhesion to the finish.

I will not attempt to go into the developments of the past that have been the finishing industry's contribution to the sale of wood, but I would like to bring up a matter that should be important to both the finishing as well as the wood industry, namely, collaboration. We have a number of times contacted the wood industry to get information on wood characteristics to help us solve finish problems arising in our mutual customer's plants. Frankly, we have never been too successful in our attempts to secure council.

For example, pin holding of a finish will come up periodically in any finishing room. This is costly to the manufacturer due to loss of production and recoating of the pieces. At times, it is the fault of either the finishing material itself, improper application, or improper preparation of the wood in the manufacturer's plant. At other times, it is the fault of the veneer itself. We do not wish to put any responsibility on the veneer manufacturer, but we would like to ha all the information possible fron this manufacturer so that we can app ach the problem more intelligently. his and other problems connected wi the finishing of wood could be sol , I am sure, if there were su ent cooperation.

We in the finishing industr can- not, of course, afford to favc any group of raw material supplier ver whose products our finishes are be applied. Our customers determi the products for us to finish. A ood many of our developments hav een created through their demands. hey are the ones who keep us on ou toes at all times. Our loyalty b ngs entirely to them.

What we have been able to a om- plish for our customers, with the co- operation, can best be exemplifi by comparing the finishes of 25 yea ago with those being used today. hat improvements have been mad in wood over the same period, fo ex- ample, in walnut, mahogany or oak? Could the customer use the ame veneer today, or have there been so many later developments that those same veneers would now be obsolete, the same as finishing materials of that era? What new woods have been developed through the years that are now being used in quantities?

Inasmuch as the finish is as es- sential to the wood industry as the wood on which it is applied is to the finishing industry, my closing suggestion would be that the wood industry set up a department or group which will work closely with us or our in- dustry, so that in our collaboration we can be beneficial to each other and do a better all-round job for our mutual customers.

Discussion

Ralph Casselman (Paine I ber Company): We get complaint nd returns on our natural finish doc be- cause the consumer frequently es not finish the door correctly. ney should be treated with a brush re- servative, and given two or three ats of varnish. We have heard rumor hat air dried silicone finishes may in sight. Do you know about these?

Mr. Rogers: As far as our m- pany is concerned, no.

[1] Presented at meeting of the Forest Products Research Society, Midwest Section, November 12–13, 1953, at Chicago, Ill.

History of Kiln Drying Associations and Kiln Drying Clubs in the United States[1]

HARRY RICH

Secretary, New England Kiln Drying Association and Professor, University of Massachusetts, Amherst, Massachusetts

Describes informal organization and growth of kiln clubs over a period of years, and tells purposes of clubs. It is pointed out these clubs are educational in nature stressing exchange of ideas and discussion of problems. Management also should be vitally interested since seasoning is very definitely a part of quality control.

THE TITLE OF THIS PAPER has been slightly altered from that which appears on your program to avoid an inference that there currently exists a national amalgamation of Kiln Drying Associations. Rather, this paper will attempt to show that even without a national organization, there is evidence of a strong cooperative effort among the dozen or more sectional groups that have sprung to life in various parts of the country. An historical analysis of this effort must cover the cause, the justified support, the needs, and the accomplishments of kiln drying associations.

There is no definite record of when the first meeting of men concerned with wood-seasoning problems took place. No doubt the Egyptians or some earlier woodworkers had their problems, conducted research, exchanged ideas and benefited thereby.

Kiln engineers, wood-working superintendents, kiln operators and other local groups have from time to time, and probably more often than we realize, met to discuss seasoning problems.

There is a fundamental similarity of seasoning problems in the various regions. The needs and the aims do not vary. Because a local group holds meetings, and becomes enthusiastic about its work another group a thousand miles away may be encouraged to follow the same course. There has been considerable exchange of information between kiln drying organizations.

The clubs and associations and the names of present secretaries known to the writer are listed as follows:

Eastern Oregon–Southern Idaho Dry Kiln Club
Mr. Orlin Osborn, secretary
Edward Hines Lumber Co.
Hines, Oregon

Central California Dry Kiln Club
Mr. Harvey H. Smith, secretary
California Forest Experiment Station
Berkeley 1, California

Washington–Idaho–Montana Dry Kiln Club
Mr. Roger Carlson, secretary
Potlatch Forests, Inc.
Coeur d'Alene, Ida.

West Coast Dry Kiln Club
Mr. Paul A. Loris, secretary
Clear Fir Products Co.
Springfield, Ore.

Southern Oregon–Northern California Dry Kiln Club
Mr. Orland Lynch, secretary
Weyerhaeuser Timber Co.
Klamath Falls, Ore.

Southern California Lumber Seasoning Association
Mr. Robert P. Inglis, secretary
Associated Molding Co.
7125–Anaheim Telegraph Road
Los Angeles, California

Redwood Seasoning Committee
Mr. Carl Varner
Hammond Lbr. Co.,
Sarnoa, Calif.

Texas Dry Kiln Club
Mr. E. D. Marshall, secretary
541-Humason Avenue
Lufkin, Texas

Southeastern Dry Kiln Club
Prof. Roy Carter, secretary
North Carolina State College
Raleigh, North Carolina

Keystone Dry Kiln Club
Prof. Wm. Nearn, secretary
Forestry Dept. Penn State College
State College, Pa.

New England Kiln Drying Association
Prof. Harry Rich, secretary
University of Massachusetts
Amherst, Mass.

Grand Rapids Dry Kiln Clinic
Mr. Steve Pryce, secretary
John Widdicomb Co.
Grand Rapids, Michigan

Some of these groups have held regular meetings for 25 years or longer; others have been formed since World War II. Economic factors of supply and demand, changes in price structure, the necessity for substitutions of species and grades, and the growing importance of quality control in fabrication have all contributed to a justification of kiln drying associations.

The greatest impetus to the growth of kiln drying associations, in fact to the development of present-day scientific techniques of kiln drying, can be traced to the research and pilot-plant work in all prases of Timber Physics conducted by the Forest Products Laboratory at Madison, Wisconsin. In addition, the Forest Utilization Service, a liaison organization between the Forest Products Laboratory, Forest Experiment Stations, Wood Using Industries and various educational and research organizations, has by means of Kiln Drying Clinics, Demonstrations, and direct contact, enabled adult education to meet the changing economic conditions associated with wood seasoning.

Perhaps of more importance than number of associations, dates, and membership is an analysis of the cause, support, needs, and accomplishments of kiln drying associations.

Wood is the oldest and most universally used material for fabrication, and yet one of the least understood because of its complicated structure and unpredictable behavior under varying moisture and temperature conditions. A wood-using plant becomes established and prospers, then it takes on a new product, or substitutes a different species or grade, or ships its products into new territory. You know what happens. The kiln operator is not given credit for the sucess but he is blamed for all wood distortions and even for climatic conditions in a different region. Sometimes neither he nor management knows the answer. Unfounded prejudices, skepticism, and even superstitions have been known to plague the most conscientious kiln operator as well as management.

When it comes to the point where a kiln operator cannot sleep nights; when a financial loss of 20 to 30 thousand dollars occurs overnight because a man is given a technical job to do but is not provided with the technical know-how; when a kiln operator realizes that someone else is dry-

ing lumber better than he and at lower cost; then he will welcome an opportunity to talk things over with an acquaintance doing similar work on the other side of town.

It is not an uncommon occurrence for a kiln operator to ask if there are any books or other available information to help him in his work. Most kiln operators have many questions to ask and often there is no one in the organization competent to supply the correct answer.

Often a kiln operator is hired because he is sober, reliable and alert. Nevertheless, such qualifications while quite essential, are rarely sufficient. An understanding of all seasoning techniques through the trial and error process requires years of time and may cost much more than some other form of technical training. Even the man with considerable knowledge of wood has his problems and his doubts.

Welcomes Opportunity

The man who is observant, sober, and reliable, whether or not he is familiar with all the causes and effects of moisture gradients, becomes intrigued with the tasks at hand and alert to new ideas and techniques. It is no wonder that the kiln operator welcomes an opportunity for contact with others having problems similar to his.

Men concerned with the management of wood-working establishments are not necessarily wood technologists. Financing, procurement, fabrication, management controls and sales may cause wood seasoning to appear trivial. Perhaps there is no one in the organization who thoroughly understands kiln drying. It is unfortunate that sometimes excessive losses occur before the part that seasoning plays in quality-control, trouble-shooting, and other phases of management is fully recognized.

Needs Support

The kiln operator needs the support and encouragement of his superiors to gain a more thorough knowledge and greater proficiency in his work. It is interesting to note the almost universal support given by units of the wood-using industry in those areas where the influence of kiln drying associations has become apparent.

"What are the prerequisites of a successful kiln drying association? Membership in any kiln drying association must be sufficiently large to justify the procurement of outstanding speakers at meetings, and management must be sufficiently interested to encourage kiln operators to attend meetings. Adult education must be a function of the association to provide opportunities to learn the fundamentals of wood-moisture relations and their connection with practical wood seasoning. An opportunity must be provided for *exchange of ideas* and *discussion of problems*. *Clearing House facilities* must be provided to handle the numerous inquiries received.

Club Accomplishment

Let us see what has been accomplished. Almost every kiln drying association and club that was in existence before or has been formed since 1946 has remained active and has functioned sucessfully. In all parts of the country enthusiastic members meet regularly and listen to qualified speakers. They often persuade men from management to attend. In fact, in many of the associations, management constitutes about an equal share of membership. The various associations funtion as mediums of Adult Education. Only a few of our wood-using establishments feel they can hire a competent wood technologist. Such a man would probably have only general supervision of seasoning and might also be concerned with problems of adhesives, machinery, finishing, and structural design, in which case he would delegate kiln dryng to a subordinate who could be technically trained in that specialized field. It is often difficult for the small outfit to justify the salary of a well trained wood specialist and consequently the problems of seasoning are delegated to some bright, dependable, but untrained employee, with the assumption that he will learn by experience. It is comparable to promoting to head surgeon, a hospital attendant who has carried bed pans for several years.

Through these associations management and kiln operators alike have been sold on the value of knowing the fundamentals of wood structure and characteristics and their application to the various techniques of seasoning. The Association provides this Adult Education through meetings of various kinds: clinics, demonstrations and other opportunities for detailed discussions and through the distribution of new information on seasoning practices.

One kiln operator has remarked, "Even before we had a kiln drying association, Joe, Al, and I used to meet at the drug store and hash over our common problems."

We believe that the wood-using industry, comprising both large and small units, is willing to underwrite, as a sound investment, the cost of Adult Education available through Short Courses, Clinics, and Demonstrations such as have been provided by the Forest Products Laboratory, Forestry schools, and other technical organizations.

Type of Meeting

The kiln operator and other technicians concerned with seasoning enjoy most the Question and Answer form of meeting. Such an individual usually has a very definite problem and he wants help. Perhaps there is someone else present who has had the same problem and solved it. Often a man will come from such a meeting with what to him is a "brand new idea".

Most dry kiln associations operate a clearing house. No secretary can give all the answers but he can refer inquiries to those competent to answer them. Of course, discretion must be used. If a man asks, what dry kiln is best, he can be sent a list of manufacturers and urged to inspect various installations. If he asks how to avoid brown stain in soft pine, he may receive a more specific reply.

Experimental work is something that intrigues all who become interested in it. There are many research projects where the man on the job has been of much cooperative value. Many members have provided written reports on tests of schedules and the field is wide open for much constructive work.

Management

During this discussion frequent reference has been made to the part Management has played in our organizations. Our concept of seasoning is that it is a very definite part of Quality Control and as such is a segment of Management. We are confident that Management is as much interested in the activities of the various associations as are the kiln operators it sends to the meetings. We believe a valuable service is rendered to the wood-using industry and we also believe our success depends on a two-fold service; to management we help make available better trained and more efficient co-workers; to the individual, carefully selected by his employer, we provide opportunity and encouragement to learn the intricacies of wood seasoning and to find satisfaction in a highly technical and interesting work.

Impressions of Scandinavian Wood Using Industries[1]

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Interesting highlights of wood using industries in various Scandinavian countries are touched on, and an advanced design prefabricated house project in Sweden is described in some detail.

WE, ON THIS SIDE of the Atlantic, are perhaps inclined to look at Scandinavia and the Scandinavians as if the four countries and their people were more or less cut from similar patterns. This is very far from being the truth. Nature and people in each country are quite different from those of the three others, and the general impression one gathers by travelling in the air is that Denmark is one large farm sprinkled with red cows, Norway one large mountain covered with snow and ice, Sweden one large forest crisscrossed by hydro-electric transmission lines and Finland one large lake dotted with forest covered islands. These are exaggerations but contain nevertheless more than an element of truth.

By the same token one gathers, by travelling on the ground, that the Dane is a jolly but sarcastic individual, the Norwegian a rugged and pioneering viking spirit, the Swede a formal and ceremonious aristocrat and the Finn a serious and somewhat melancholy idealist. No doubt these—again on my part deliberately exaggerated—national characteristics are associated with the farm, the mountain, the forest and the lake which all have left their individual imprints on the inhabitants but, in spite of dissimilarities and of the fact that the Scandinavians have battled each other thoroughly and bloodily from prehistoric times to comparatively recently, they are excellent friends and have developed an unusual spirit of cooperation, not least in matters pertaining to their forest industries, which is probably matched only by the parallel type of friendly intercourse between ourselves and the people of the United States.

From the points of view of natural resources and industrial development Sweden is foremost among her neighbours in the North and, in order to avoid statistical comparisons which would be dull in the extreme, I shall confine the subject matter of this paper to my observations in that country with only a short side trip to Finland.

[1] Presented at meeting of Forest Products Research Society, Eastern Canadian Section, May 4-5, 1954, at Ottawa, Ont.

Because of the similarity of climate and soils and the cooperative spirit of the people the forest industries in particular have developed along similar lines in Norway, Sweden and Finland. There is consequently no need for entering into separate descriptions or for drawing comparisons between one country and the others in a purely informal narrative such as this.

Sweden is our most formidable European competitor as far as forest products are concerned. She has a total land area of 173,000 square miles of which 56%, or some 57 million acres, may be considered as productive forested area. In proportion to size Sweden has more forest than any other country in the world except Finland.

This enormous forest, which covers the country throughout its nearly 1,000 miles of length, is interspersed with agricultural and meadow lands which occupy only about 11% of the total area and the bulk of which are located in the South. The remainder of the country, or 33% is barren mountains, unreclaimable swamps and lakes. It is therefore no wonder that the aerial view creates an impression of one vast, unbroken forest. The beforementioned hydroelectric power lines, which extend from North to South and which branch out in all directions, serve Sweden's 7 million people and their highly developed railroad systems, steel mills, forest industries, cement works, etc.

The Swedish forester is indeed lucky. To all intents and purposes he has to deal with only two species of softwood, Pine and Spruce, together with a sprinkling of hardwood species, Birch and Poplar in the North and Beech in the South. There are, of course, other species of trees growing in Sweden, Larch, Oak, Ash, Elm and Maple but, insofar as the bulk of the forest industries are concerned, Pine, Spruce, Birch, Poplar and Beech are the only important ones.

The forests of Sweden are intensively managed. Forest research is highly developed and is carried out by numerous interlocking organizations within the Government as well as the industries. The producing capacity of the forest soils, the physical characteristics of which incidentally are quite similar to those of Canada, is naturally quite variable because of differences in climate and altitude between North, South, East and West. The total growing stock, according to the most recent national forest inventory, is 60 billion cu. ft. and the annual growth, averaged over the whole country, is estimated at 1.8 billion cu. ft. or 32 cu. ft. per acre per year.

Discounting this total annual growth for logging waste, sinkage and losses caused by fires and insects—the two last being practically negligible—it is estimated that the annual wood producing potential of Sweden is in the order of 1.5 billion cu. ft. Since the average annual cut after the war has not exceeded 1.4 billion cu. ft. it will be seen that Sweden is carefully husbanding her forest resources and that she is in no way encroaching on her forest capital. The distribution of Sweden's annual cut to various uses is, roughly, 38% to lumber and wood using industries other than pulp and paper, 35% to pulp and paper and 27% to firewood.

It was the forest wealth of Sweden which, some 300 years ago, made her the foremost iron producer in the world. Immense timber resources were available within easy reach of the blast furnaces and, even today, considerable quantities of charcoal are being produced for the steel industry, although this particular use of wood is rapidly diminishing because of the conversion to electric furnaces.

The old Swedish iron and steel companies, many of which were incorporated in the 17th century, have grown into highly diversified concerns because of their century old ownership of natural resources: Iron ore, forests and water power. Today they operate highly integrated and yet many-sided production centres of steel mills, pulp and paper mills, sawmills, wall board mills, plywood mills, prefabricated house factories, electro-chemical plants, etc.

It is this concept of integration which currently characterizes the Swedish wood using industries and which, since the end of the war, has resulted in a steady increase of both productivity per worker and total production. The largest company in Sweden, The Swedish

Cellulose Corporation, which controls and operates numerous integrated plant units in the northern section of the country, thus manufactures not only all the numerous products derived from Sulphate and Sulphite Cellulose, including the chemical by-products, but also lumber, doors, windows, laminated flooring, joinery and prefabricated houses.

This highly developed integration of the industry, which applies not only to the old and established concerns but to the newcomers in the field as well, has resulted in a remarkably high level of utilization of the annual cut of wood.

There is a constant and efficient flow of so-called "waste" between the individual units in each individual group of plants generally located side by side. Sawdust and chipped slabs from the sawmills are delivered by bucket conveyors to the sulphate and wallboard mills; sulphite liquor is pumped to the chemical plants for conversion to industrial alcohol, fodder yeast and other distillation products, while sawn and planed lumber from the sawmills is partly diverted to sash, door and flooring mills as well as to the prefabricated house factories. Pickets, boxboard and block-board are also common by-products of the sawmills which, in addition, often operate auxiliary wood preservation plants where telephone and transmission line poles are pressure creosoted or variously treated with other wood preservatives.

The Scandinavian Plywood industry has reached its highest development in Finland where nearly 20% of the total growing stock in the forests is made up of the two birch species:. Betula odorata and Petula verrucosa. The first Finnish plywood mill was built in 1911 in the heart of the extensive Birch forests of Central Finland. The industry subsequently expanded throughout the lake district of Central and Southern Finland and, today, there are over 20 plywood mills in the country. These mills consume about 30 million cu. ft. of raw wood annually and turn out the equivalent of some 350 million square feet of ¼" board.

The Finnish Birch is—as the Canadian—a pioneer tree and one of the first species to occupy denuded lands. For this reason it comprises such a high proportion, by area as well as volume, of the Finnish forests, where forest fires and colonization by burning were rampant right up to the end of the 19th century. Consequently, the central lake district of Finland is today characterized by extensive and excellent stands of Birch which are the backbone of the flourishing Finnish plywood and bobbin industries. This prevalence of Birch in Finland is in direct contra-distinction to Sweden where extensive forest fires as well as colonization have been out of the picture for practically a century. In fact, many Swedish pulp and paper companies, including the Cellulose Corporation and the Government Forest Service, deliberately eradicate Birch from certain forest areas by spraying mixed stands from the air with hormone-type chemicals such as 2,4-D and 2,4,5-T.

The Finnish plywood mills are modern and efficient. The labour is almost entirely female and the degree of utilization of the raw wood is extremely high when the generally small-dimensioned raw material is considered. The lathes, operated in banks of 10 or more, are equipped with automatic centering devices and the logs are peeled down to a 2" core. The waste is cut to a minimum and the cores are used in the bobbin and wallboard plants. Many Finnish plywood mills also manufacture blockboard from sawmill trimmings and, as in Sweden, the industry is highly integrated with other wood using industries. The raw material is however small and of low grade. The specifications of a veneer log are very simple. Any tree which is reasonably straight and sound and which has attained a diameter of 7" at 18 ft. from the ground is acceptable. The Finnish mills are therefore producing only about 10% of high grade plywood; the bulk of the output is of low grade and cannot be considered as competing with the products of large dimensioned, high quality Canadian hardwoods in the world market. Most of Finland's small high grade plywood production is absorbed by the domestic market—and the Finns are past masters in the art of advertising and using pulpwood—while the low grade output is exported, chiefly to Europe and the U.S.S.R.

After this brief excursion into Finland, which was necessary for the purpose of sketching the Scandinavian plywood industry concentrated in that country, we shall return to Sweden and, in order to get away from a too dry exposition of the subject, we shall have a look at a specific forest products industry which I hope will graphically illustrate the concept of integration as practiced in Sweden as well as the high level of technical development characterizing the wood using industries of that country.

This industry is a prefabricated house factory located in Dalarne in the heart of the iron ore country in central Sweden. It is perhaps significant that the initiative which resulted in the birth of this enterprise was taken by one of Sweden's large combines of water power, iron ore and forest products interests which had its origin in the latter half of the 17th century. This company was faced with the problem of providing adequate and yet economical housing facilities for its ever growing staff of steel mill and forest workers. In cooperation with a large cement company in Southern Sweden it established, in 1944, a special research center charged with the development of a mass production dwelling for industrial workers. By 1949 the work of this research organization had progressed to a point where it became possible to form a Company, known, in rough translation, as "The Elementary House Corporation."

In a highly socialized state, such as Sweden, it was inevitable that the charter of this company should be strongly slanted towards general social welfare. The dividends on stock in the company were thus limited to 5% and, by the same token, the Government imposed a series of regulations which were designed to keep the products out of the speculative market. The prefabricated houses were to be sold at a price which included only the cost of production plus the limited dividend distribution and the necessary amortization of plant and equipment. The savings effected through mass production techniques and integration were to be turned over in full to the future owners and/or tenants in the form of low original cost or rentals. The company, when finally formed, was controlled by a number of large business enterprises interested in this field as well as by the Swedish Association of Farmers and, in addition, the Government contributed, at the start, with a low interest loan.

The research and subsequent development of the housing units, now manufactured in the Company's highly integrated plant, were based on the following assumptions:

1. The whole complex of problems must be attacked as a unit. Construction and manufacturing process must be so developed that the requirementss of both can be fully satisfied.

2. The design of framework, partitions, roofing members, fittings, exterior and interior trim must be coordinated and adapted to one another.

3. Methods of storing and transporting of individual building parts must be worked out in connection with the shapes and forms of these parts.

4. The erection and assembly on the building lot must be predetermined and organized in all details.

5. The project must include all items necessary for the production of a housing unit in all respects ready for occupancy.

6. The approach to the whole problem must be along purely technical and economical lines. No special materials must be recommended except those which are found to be the most practical and economical for the purpose.

No attention must be paid to the usual practices of construction or to any present collective agreements within the building trades if new ways of doing things can be found.

These premises were strictly adhered to and the company's plant has now been in full operation for about three years. The building complex is located on the shores of a lake through which runs a small river draining the watershed of the company's freehold timberlands. The buildings consist of a sawmill, a planingmill and a carpenter shop, a central manufacturing plant, a roofing factory, a plumbing and electrical shop, a central heating plant and a large storehouse. In addition there is a dry kiln, a lumber yard and the necessary railroad sidings and interconnecting trolley tracks between the various plant units. All machinery is, of course, electrically driven and waste products from the various units are partly burned in the central heating plant and partly chipped for use in a nearby wallboard mill.

The sawmill turns out spruce lumber of a single size, measuring roughly 1½" x 4¼", together with some specially dimensioned elements. After suitable drying in the yard and in the kiln these elementary building boards are diverted to the central manufacturing plant, the roofing factory or the planing mill and carpenter shop for further processing.

The central manufacturing plant is fully automatic and occupies only 35 men in all. The basic board units are ripped into six thin boards, about ¼" x 4¼", which are planed, assembled and glued together into a hollow, square column measuring roughly 8" x 10". This column, built up from two 3-ply walls separated by strips of hardboard, emerges from the completely automatic assembly machine as a continuous unit without end. The machine assembles, glues, presses and finally dries the various elements by means of built-in electrodes connected with a high frequency generator. The endless column is cut into lengths of approximately 8.5′ by an automatic slasher controlled by photo-electric cells. These columns are the "elements" or building blocks which have given the company its name.

The whole process is incredibly ingenious and actually defies verbal description. The columns, emerging from the machine in two sizes, one being roughly half the thickness of the other, are filled with tamped sawdust and shavings, also by a fully automatic machine, and are finally transported on conveyors to various assembly lines where some are cut into different lengths for various purposes, others are fitted with electrical conduits, again others are pre-cut to provide for certain elements of the plumbing installation, etc.

They all finally reach the painting shop through which they travel like pigs in a slaughterhouse and where they are spray-gun painted as they move along. After drying they are packed in bundles of 20 and are finally transported by fork-lift trucks to the storehouse. The elementary columns, the larger size for the exterior walls and floors, the smaller size for the interior partitions, are produced in a continuous process at a rate of 30 ft. per minute.

In the meantime the other units of the plant are turning out floor and ceiling units, pre-cut rafters, bathroom floors complete with marboleum, doors and windows, electric wiring, plumbing and heating units, eaves, troughs and spouts, prefabricated chimney elements, etc. The production is synchronized with the central manufacturing plant so that material flow from the various plant units to the storehouse at the rate of two complete, story and one-half 6-room houses per day, or 600 houses per year.

In the store house, to which all auxiliary equipment, such as electric stoves, refrigerators, bathroom fixtures, furnaces, radiators, hot water tanks, etc. are delivered from outside manufacturers, all the various units making up the complete house are packed in standard 5-ton packages making up one complete heavy truck or ½ freight car load. Four such packages make a complete house, exclusive of foundation of course, and the company's own trucks transport the materials to the customer's building lot anywhere in Sweden.

The customer is expected to provide his own foundation walls and basement to the company's specifications. Specially trained erectors then set up the house in about two weeks' time. Only four men are required for this. Special arrangements with the trade unions permit these four erectors to carry out all the work, including plumbing and electrical.

The main elements of the house thus consist of the hollow, insulated columns which form all exterior and interior walls, floors, ceilings, joists, beams and columns. These are rapidly erected and held together with wooden dowels. There are practically no nails and only very few bolts in the entire structure. The roofing material is invariably tiles which in Sweden are very cheap.

The cost of these houses to the purchaser varies with the model, of which there are several, but a standard house, 25′ x 32½′, with full cellar and consisting of 4 rooms and entrance hall downstairs, 2 unfinished half-story rooms upstairs, and including all trim and painting, electric washer, pantry, electric stove, electric refrigerator, stainless steel sink, kitchen and clothes cupboards, complete bathroom with plastic tiles, stairway to the second story, chimney, furnace, hot water heating system and electrical fixtures, is delivered and erected, ready for occupancy for 27,000 Swedish Kroner. This is approximately $9,000 in terms of present-day purchasing value of the Krone. If we include the concrete foundation which, as previously mentioned is erected by the purchaser, the total cost of the completely finished house does not exceed 33,000 Kroner, or approximately $11,000 if we base the comparison on purchasing power rather than exchange value. In terms of straight exchange value the cost of the house is actually less than $7,000. The saving in one of these houses is actually less than $7,000. The saving in one of these houses to the purchaser, compared with a similar house built to the same standards by conventional methods, is probably in the order of $3,000 plus about 2 months of time.

My purpose, in describing this amazing Swedish enterprise in some detail, has been to give one example of how sound forest products research and technical skill of a high order has resulted in considerable social benefits in relieving the housing shortage which in Sweden is as acute as here in Canada. At the same time, this enterprise illustrates most vividly what can be accomplished by integration and mass production techniques which here have resulted in what virtually amounts to the steady flow of completely finished houses from the stump to the building lot at the rate of two per day.

The spirit of cooperative research has reached a peak of development in Scandinavia since the end of the war. Many individual companies operate relatively large research laboratories themselves, and in a number of cases whole groups of industries have invested large sums in setting up and maintaining research institutions jointly. The Swedish Government shares to a considerable extent in the expenses of these research centers as well as in those maintained by the universities and institutes of technology. Nevertheless, over 85% of the total spent on research in Sweden today comes from business companies and other private sources. Thus, in spite of the socialist rule, which has held sway in Sweden for many years, and in spite of the cooperatives which unquestionably have played an important part in raising the Swedish living standards to their present high level, free enterprise and regular capitalistic business undertakings form the main framework of industry and commerce in that country and highly developed cooperative research is the backbone of that framework.

A Special FPRS Feature

Around the World in Forest Products Research and Development

Guest Editor, G. M. HUNT

Division of Forest Products—Commonwealth Scientific and Industrial Research Organization—Australia

STANLEY A. CLARKE
Chief of Division

Describes organization of laboratory, its major fields of work, and methods of publicising the results of research.

AUSTRALIA, with a population of about 9,000,000 people has a total area of about 3,000,000 square miles. Of this area 1,000,000 square miles has low rainfall (below 10 in. annually), a further 1,000,000 square miles has light to medium rainfall, suitable for pastoral purposes, and the balance has a good rainfall. This last includes good agricultural and dairying country as well as rough mountain areas and consists of a belt around the coastline of the continent, much wider on the east than the west and with a break to a low rainfall in the south and north-west portions. The total forested land covers about 200,000 square miles but, of this, only 70,000 square miles can be regarded as exploitable or potentially exploitable forest. The area reserved as State forests and timber reserves is 45,000 square miles.

The forests include brush, rain forest, wet coastal and dry interior types. Hardwoods (pored timbers) of the genus *Eucalyptus* greatly predominate. The softwood resources, originally limited, have been seriously depleted and extensive plantings are being undertaken.

Australian forests are at the present time producing raw material annually for about 1,200,000,000 board feet of sawn timber, 150,000,000 sq. ft. (3/16 in. basis) of plywood, as well as large quantities of piles, poles, posts, mining timbers and fuel wood. The pulp and paper industry, with a total production of about 300,000 tons of paper and board per year, produces about 150,000 tons of pulp, chiefly from eucalypts. About 50,000 tons of insulating and hardboard are also produced.

Politically, Australia is divided into six States. Forest authorities within each State control the forests on Government lands. There is also a Federal Forestry and Timber Bureau interested in interstate and overseas movement of timber, forestry research and education, and the rather limited forest resources of the Australian Capital Territory and the Northern Territory of Australia.

The Division of Forest Products with its Forest Products Laboratory is independent of all these forest authorities. It is one of the Divisions of the Commonwealth Scientific and Industrial Research Organization (C.S.I.R.O.), a semi-governmental organization working under its own Act of the Federal Parliament and answerable to a Minister (at the present time the Minister for External Affairs). This is in contrast to the Forestry and Timber Bureau headed by a Director-General, which is a Section of the Commonwealth Public Service and a branch of the Department of Interior, which is answerable to the Minister for the Interior.

C.S.I.R.O. is controlled by an Executive of three full time members, consisting of a Chairman, a Chief Executive Officer and another member, all scientists, and two part-time members, one from industry and one from the Federal Treasury. The bulk of the funds for the Organization are provided by the Federal Government but industry makes substantial contributions towards some branches of the work. However, the Organization retains the right of determining the research programs and of controlling publication of results.

In view of the fact that the States own about 70 per cent. of the forests, it is not surprising that the forest products research was commenced by State authorities. However, the need for a national forest products laboratory was recognized and recommendation for its establishment was made as early as 1916. A Director was appointed in 1919 and, although some lines of work were undertaken from funds provided jointly by State and Federal governments, no permanent laboratory was founded. However, sponsored research was pursued in the fields of pulp and paper and tannin while, in addition, some of the States carried out independent investigations chiefly in the field of timber seasoning. With the formation in 1926, of the Council for Scientific and Industrial Research, the precursor of the C.S.I.R.O., two research students were sent to Madison for two years' training and in 1928 the Division of Forest Products was founded and a Chief of the Division—Mr. I. H. Boas—was appointed. The Division grew rapidly in its early years in spite of the depression, and further officers were sent overseas for training. In its first eight years it was housed in temporary buildings. In 1936 the Division moved to its present location—

69–77 Yarra Bank Road, South Melbourne, just outside the boundary of the city of Melbourne proper. Here the Division is still located, the postal address being P. O. Box 18, South Melbourne S.C., Victoria, Australia.

The Division has a total staff of 225, including 70 professional officers, and the total floor space is 58,000 sq. ft. The area of the site, approximately one acre, has proven too small and the laboratory accommodation is cramped. Experimental timber supplies, stores and laboratory equipment not immediately required, and seasoning stacks etc. are therefore stored elsewhere. The Division is divided into eight Sections as follows:

Wood and Fibre Structure
Wood Chemistry
Timber Physics
Timber Preservation
Timber Mechanics
Timber Seasoning
Veneer and Gluing
Utilization

In addition, personnel of the independent C.S.I.R.O. Section of Mathematical Statistics are located at the Division and, although under independent control, work almost as an additional section of the Division.

Wood and Fibre Structure Section

The section is concerned first of all with the anatomy of timbers and methods for their identification. It is particularly interested in timbers of the Southwest Pacific region and a systematic study of these by families is in progress. The anatomy of barks, certain growth studies of trees, the relationship between anatomy and properties, and the behaviour of reaction wood are also under investigation. The section is strongly interested in cell wall structure, the factors influencing cell formation and organization, and the relationship of these to the subsequent behaviour of wood and pulp. It is well equipped with ultra-violet and phase-contrast microscopes, with X-ray diffraction apparatus and with an electron microscope. In this section also a study is made of the extraneous materials, tannins etc. of woods and barks.

Wood Chemistry Section

This section includes work on pulp and paper and has been divided into three groups:

Pulp and Paper Technology: This group is concerned with methods and equipment for pulp evaluation and paper testing and the pulping characteristics of Australian and New Guinea timbers. Special studies have been made of laboratory beating and paper-testing equipment.

Paper Physics: This group is a newly formed one and is interested in the structure of paper, the fundamentals of beating and like problems. It is equipped with a versatile rheometer designed and built in the Division.

Wood Chemistry: This group is concerned with the cellulose, hemicellulose, and lignin components of wood, particularly from the pulping standpoint. Current investigations include lignin isolation and characteristics, a study of the resistant and non-resistant hemicelluloses and alkaline cooking kinetics.

Timber Physics

The Timber Physics Section is primarily interested in sorption phenomena in cellulosic materials, the mechanism of creep in timber under long time loading, the electrical and thermal properties of wood and the effect of temperature on physical and mechanical properties. In addition, more routine topics such as the density and shrinkage of timber, electrical resistance moisture meter corrections for species, and the physical properties of wallboards are studied. Equipment of particular interest includes a special calorimeter for the study of heat of sorption and apparatus for the simultaneous determination of thermal conductivity and specific heat by a dynamic method. The section also acts as an instrumentation center for the whole of the Division.

Timber Preservation

As well as carrying out work on wood preservation, this section also includes studies of a mycological and entomological nature. Laboratory and field decay tests, laboratory tests with *Lyctus* and *Anobium* and field tests with termites are also carried out. The Division co-operates with the Division of Entomology, C.S.I.R.O. in termite field tests, laboratory termite colony tests, and other insect studies. A simple dip treatment with boric acid and borax followed by block stacking for a few hours to prevent *Lyctus* attack in veneers was developed and has been widely adopted by industry. The problem of impregnating the heartwood of the refractory eucalypts with preservatives has yielded to the use of pressures of 1,000 lb./sq. in. and a pilot cylinder 10 ft. long by 2 ft. in diameter is in operation for this work.

Timber Mechanics

Here again, part of the work of the section is of a more routine nature and part more fundamental. In the former class are mechanical tests on Australian timbers, tests on fastenings such as timber connectors and nailed joints and tests on built up structures. More basic work concerns the development of column formulae taking into account long-time-loading effects, the study of growth stresses which occur in trees and the relationship between silvicultural treatment in the forest and properties of timber. The laboratory is temperature controlled and equipped with two lever and three hydraulic universal testing machines of modern design. The largest machine has a capacity of 600,000 lb. with a 24 ft. column and the smallest universal machine is of internal manufacture and has a capacity of 500 lb. Toughness, Izod, puncture, and hardness machine are included and a micro-tensile tester has been developed for use in silvicultural studies.

Timber Seasoning

Work on kiln drying schedules, air seasoning, stacking and handling, etc., and many applied drying problems received from industry is being continued. However, over recent years, greatest attention has been given to studies on kiln drying difficult hardwood veneers, E.M.C. relationships at high temperature, vapor drying, and the quantitative assessment of drying degrade. Fundamental studies on drying and collapse have also been commenced. A considerable amount of work has been carried out on kiln and special drier design, and practically all the kilns in Australia have been erected to designs prepared by the section. Work has also been carried out on sawdust-concretes, woodwool-cement boards and woodwaste-binder boards.

Veneer and Gluing

This section is equipped with a lathe, drying, and pressing equipment and carries out studies on Australian and New Guinea timbers. The work of this section, particularly in the adhesives field, has recently been reduced to enable the staff to be allocated to urgent work in other sections.

Utilization

This section is concerned in the correct use of timbers, the collection of information for the preparation of Australian grading standards, the improvement of conversion practices and in waste prevention and utilization. The section assists industry with advice on the design of sawmills and woodworking plants, the integration of industry, and preliminary investigations have been carried out on the cutting action of circular and power-chain saws.

Mathematical Statistics

This section works in close cooperation with all the sections of the Division and assists in the design of experiments and the analysis of data. The

Division pays particular attention to statistical method and this is evidenced by its modification of standard sampling methods for mechanical tests and the collection of a reproducible wood sample for mechanical work.

Each Section Head is responsible for preparing each year a program of work for his section and, after discussion, these are incorporated in a program of work of the Division which is issued in August each year for the period July—June. To assist in the planning of programs, two annual conferences are held: a Forest Products Research Conference and a Pulp and Paper Cooperative Research Conference. The Forest Products Research Conference is attended by representatives of all the State Forest Services, the Commonwealth Forestry and Timber Bureau and several other organizations interested in forest products research. Current work and proposals for new work are discussed freely.

It should be recognized that the Division does not carry out all the forest products work in Australia. The State of New South Wales has established a Division of Wood Technology, and Queensland a Forest Products Research Branch in their Forest Services, and both of these have substantial programs of work dealing particularly with problems of local interest and those of an applied nature. The function of the Forest Products Research Conference is to keep all research workers informed of the progress of work to avoid overlap and to draw attention to any particular problems requiring investigation.

The Pulp and Paper Cooperative Research Conference is attended by technical officers from three Australian and one New Zealand paper company who contribute to the funds of the Division to assist in pulp and paper work. At this conference the Division reports on its work for the year, and invites discussion and suggestions for modifications or additions to the program.

Publications

The results of the work of the Division are first prepared in the form of internal reports. Most of these are mimeographed and given a limited circulation amongst other research laboratories and individual research workers who are likely to be interested. Completed projects are published in one of the Journals of the C.S.I.R.O. which are as follows:

Australian Journal of Biological Sciences
Australian Journal of Physics
Australian Journal of Chemistry
Australian Journal of Applied Science
Australian Journal of Agricultural Research
Australian Journal of Marine and Freshwater Research
Australian Journal of Botany
Australian Journal of Zoology

Pulp and paper work is often published in the Proceedings of the Australian Pulp and Paper Industry Technical Association (APPITA). Occasional articles are also published in other publications, such as the Journal of the Australian Institute of Foresters, Australian Timber Journal or sometimes in overseas publications. The Division publishes a News Letter at intervals describing work of interest to industry. This News Letter also includes articles of a general informative nature. Bulletins are also published by the C.S.I.R.O.

Two publications prepared by the Division—"The Handbook of Structural Timber Design" and "The Commercial Timbers of Australia — Their Properties and Uses", although published by C.S.I.R.O., are not distributed by them but sold by the Tait Publishing Co., 349 Collins Street, Melbourne. The Division also has a Trade Circular series giving information in a form suitable for assimilation by woodworkers, foremen and others in industry.

All publications, with the exception of the "Handbook of Structural Timber Design" and the "Commercial Timbers of Australia" are free and obtainable on application to the Chief, Division of Forest Products, C.S.I.R.O., P. O. Box 18, South Melbourne, S.C.5, Victoria, Australia.

The Film Unit of C.S.I.R.O. has prepared a color film "Science and Wood" showing the activities of the Division and more recently a black and white film on "The Maintenance and Sharpening of Power-Saw Chains".

BAMBOO

G. M. Hunt

Bamboo is a forest product, a plantation product or a garden vegetable, depending on where it is obtained, when it is harvested, and how it is used. From whatever source, however, bamboo is of immense economic importance in many parts of Asia and tropical America, and, in literally hundreds of ways, enters into the daily life of the people. Not all of the 600 to 700 species of bamboos in the world have commercial value but some of them are of outstanding usefulness. One species, for example is widely used in Japan, in the form of bambo sprouts, as a vegetable. An average of about 150 million pounds of the sprouts per year are said to have been produced for food purposes in Japan during the 3-year period 1941 to 1943 inclusive. In 1945, some 15 million bundles of bamboo were harvested in Japan for other purposes. The bundles are 6 to 8 inches in diameter and of varying lengths.

In the Philippines, bamboo is used for almost every purpose for which wood is used in temperate climates and large quantities are removed from the Philippine forests under license from the Bureau of Forestry. According to Gooch, "Bamboo builds and supports native huts; goes into chairs, cupboards, tables, beds, screens, water containers; and when split it is woven into a coarse matting . . . for the sides of houses, room partitions, floors, and boats." It is also used for bridges, fences, building staging, fish traps and roof tile and endless variety of other purposes.

One of the great advantages of bamboo is its adaptability for home use and for manufacture by small industries into products for domestic use or export. It is grown widely in Japan in small plots and larger plantations as well as around the houses in the villages. Whole families occupy themselves during bad weather or winter months making useful bamboo articles for home use and for sale. Similarly in the Philippines and elsewhere, bamboo is the raw material for innumerable small local industries, some of which manufacture products for export.

The use of bamboo for paper making goes back at least 2000 years when the Chinese were using it for that purpose. Extensive laboratory and pilot plant studies by the Indian Forest Research Institute at Dehra Dun India on bamboo in the 1920's laid the technical foundation for the successful commercial use of bamboo for high quality paper and nearly 250,000 tons are now used annually by the pulp and paper mills of India and Pakistan.

Although the bamboos are true grasses, characterized usually by the hollow stems that are closed at the joints or nodes, they have many of the desirable properties of wood and are used for similar purposes. They grow rapidly, often increasing a foot in length in a single day and, in extreme cases, much more. They usually attain their full growth in one season but may require 2 to 5 years to ripen or harden. Some species, under favorable conditions, grow as tall as 80 feet and 5 to 8 inches in diameter.

Some species of bamboo are quickly attacked by powder-post beetles and may be practically destroyed in a year while other species are much more resistant. In the Philippines there is a pipe organ with bamboo pipes which has been in use many years.

Bamboo is not naturally decay resistant and gives only limited service under conditions favorable to fungus growth but it can be preservatively treated with water-borne salt preservatives by methods worked out at the Forest Research Institute in India. Reducing the starch content by allowing the fresh culms to stand in water for some time before removing the leaves, or by long soaking of the trimmed culms in water is said to reduce the danger of rapid destruction by powder-post beetles and of staining by fungi.

Sources of Information:

Anon: Production, consumption and stockpiles of bamboo, Report No. 27 General Headquarters, Supreme Command for the Allied Powers, (Japan, (April 1946)

Bhargava, M. P.: Bamboo for pulp and paper manufacture, Indian Forest Bulletin No. 129, (1945)

Gooch, Winslow L.: Forest industries of the Philippines, United States Mutual Security Agency, (May 1953)

Abstracts of Important Wood Industry Publications

Abstracts published in the Journal are picked by a subcommittee of the Publication Committee of the Society. Members of this subcommittee: Publications Committee Vice-Chairman in Charge of Abstracts, Frederick F. Wangaard, Professor, Yale School of Forestry, New Haven, Conn.: Forestry Abstracts; S. B. Preston, School of Natural Resources, U. of Michigan, Ann Arbor: Technical Bulletin of the Furniture Development Council; J. F. Saeman, Chemist, U. S. Forest Products Laboratory, Madison, Wis.: Chemical Abstracts; C. E. Frubesky, Chemist, U. S. Forest Products Laboratory, Madison, Wis.: Bulletin of the Institute of Paper Chemistry.

Properties of Wood

Horvat, I. Prilog poznavanju tehnickih svojstava duglaziejevine (*Pseudotsuga taxifolia* var. *viridis* Asch. et Gr.) **[Technical properties of Douglas Fir wood.]** *Sum. List* 77 (3), 1953 (105–14). 20 refs. [Croat. croat.]

Presents tabulated results of tests on wood specimens taken from 5 Douglas Fir logs at heights between 1.3 and 3 m. The stems, felled in a Slovenian forest, averaged 41 cm. d.b.h. and 37 m. length; age 63 years. In the following figures the bracketed values are the average ones: ring width 1.38–10.00 (3.53) mm.; late wood % 27–72 (47.7) %; density—air-dry (12.2% average m.c.) 0.442–0.787 (0.590), oven-dry 0.419–0.769 (0.564), nominal 0.402–0.593 (0.486) g./c.c.; shrinkage: [to air-dry?] radial 4.24–7.46 (5.70), tangential 5.00–11.09 (8.65), volume 9.78–18.38 (14.39) %; compression strength 374–816 (559), bending strength 1001–1808 (1302) kg./sq. cm., and work to maximum load 0.369–1.46 (0.793) kg.m./sq. cm. [Forestry Abstracts, V. 15, No. 1]

Krzysik, F., and Gonet, B. Fizyczne i mechaniczne wlasnosci drewa niektorych gatunkow i kryzowek topoli. [Physical and mechanical properties of the wood of some Poplar species and hybrids [in Poland].] *Sylwan* 96 (4), 1952 (433–68); 97 (1), 1953 (28–46). 35 refs. [Pol.russ.e.]

Presents tabulated and graphed results of 6129 measurements on wood specimens taken from 3 stems of *Populus alba*, 4 of *P. canescens*, 2 of *P. berolinensis*, 3 of *P. tremula*, and 2 of *P. deltoides*, 10 of the trees being 21–31 years and the remaining two 50–59 years old, and all being free-grown except *P. tremula*. Heartwood varied from 11·6 to 43·5% of the volume. Moisture content of the sapwood varied from 64·7 to 131·6%, that of the heartwood from 67·8 to 191·1%. The growth rings varied in width from 3.5 mm. (*P. canescens*) to 10·4 mm. (*P. deltoides*). The oven-dry density of *P. canescens* wood from two sites averaged 0·386, and 0·515, g./c.c., respectively. Average porosity varied from 66·6% (*P. canescens*) to 79·6% (*P. berolinensis*). *P. deltoides* seems to give best results in the plantation growing of pulpwood. [Forestry Abstracts, V. 15, No. 1]

Herzig, J. Bestimmung der Trankreife von Holzmasten und Schwellen mit dem elektrischen Siemens-Holzfeuchtemesser. [Using the Siemens electrical moisture meter for determining if wooden poles and sleepers are ready for impregnation.] *Holz Roh- u. Werkstoff* 11 (5), 1953 (179–82). [G.g.] P.R.

Describes a series of m.c. determinations carried out with pin-type and clamp-type electrodes, and gives a calibration table obtained by the drying-oven method for both electrodes, wood surface and disk sample, for the m.c. range 15–25%. [Forestry Abstracts, V. 15, No. 1]

Reichert, T. Neues Holzuntersuchungsverfahren zur Bestimmung von Feuchtigkeit, Derbgehalt, Raumdichtezahl, Rohwichte, Schwund und spezifishche Gewicht. [A new method of determining the following data for wood: moisture content, solid content of stacked wood, basic density, oven-dry density, shrinkage, and specific gravity.] *Holz-Zbl.* 76 (86), 1950 (938–40). [G.]

Describes the application of the 'Hygrodasymeter', an instrument designed recently in Germany for determining different physical properties of wood. [Forestry Abstracts, V. 15, No. 1]

Malmquist, L. Beobachtungen zur Hygroskopischen Hysterese von Holz oberhalb 100° C. [Observations on the wood moisture content hysteresis above 100° C.] *Holz Roh- u. Werkstoff* 11 (5), 1953 (174–5). 1 ref. [G.g.] P.R.

A kind of hysteresis could be observed in absorption/desorption experiments with Pine and Spruce specimens, when the time curve of the specimen weight was analysed. A hysteresis loop of ca. 2/ moisture content was obtained, which is at variance with previous findings [cf. *For. Abstr.* 14 (No. 1682)]. It seems that the weight-changes occur discontinuously. [Forestry Abstracts, V. 15, No. 1]

Abstract Sources

The preparation of abstracts from world literature in many languages is so highly specialized and costly that the Forest Products Research Society has no abstracting service of its own. For the abstracts in this issue of the JOURNAL the Society is indebted to the respective abstract journals indicated, from which they have been selected with the kind permission of the editors. Readers wishing information in addition to that given in these abstracts should consult the original articles referred to. Copies or additional information can not be supplied by FPRS or the abstract journal. The journals from which abstracts are published in this issue are as follows:

BULLETIN OF THE INSTITUTE OF PAPER CHEMISTRY, published monthly at Appleton, Wisconsin by the Institute of Paper Chemistry, subscription price $25 per year. This Bulletin publishes over 3,600 abstracts per year on subjects of interest to manufacturers of pulp, paper, fiber board and allied products.

CHEMICAL ABSTRACTS, published semimonthly by the American Chemical Society, Executive Office—1155 Sixteenth Street, NW, Washington 6, D. C., subscription price $60 per year plus postage. This abstract journal publishes many thousands of abstracts annually with broad coverage of world literature in the entire field of chemistry and allied subjects.

FOREST PRODUCTS AND UTILIZATION ABSTRACTS are published quarterly by the Commonwealth Agricultural Bureaux of London, England, as a separate reprint of decimal sections 3, 7, and 8 of Forestry Abstracts, for the facility of those interested chiefly in the field of wood utilization. The abstracts are prepared by the Commonwealth Forestry Bureau, Oxford, England, and the utilization section contains about 1,200 titles and abstracts per year from literature in some 30 languages and covers all aspects of forest utilization from cutting and extraction through marketing, mechanical, and chemical processing to minor forest products. FPRS members interested in obtaining the complete issues of Forest Products and Utilization Abstracts should communicate with the Secretary of the Society.

TECHNICAL BULLETIN OF THE FURNITURE DEVELOPMENT COUNCIL is published bimonthly by the Council at 11 Adelphi Terrace, London W. C. 2, England. The Technical Bulletin publishes hundreds of abstracts and reviews from world literature annually, relating to the various phases of the furniture manufacturing industry. Subscription price is $5 per year.

Matsumoto, T. [The anisotropic shrinkage of wood.] *Repr.* from *Bulletin, Morioka College of Agriculture and Forestry, Iwate University* No. 26, 1950 (81–8). 3 refs. [Jap.e.] X.

Frey-Wyssling's experiments were repeated [cf. *For. Abstr.* 3 (135)] but the results obtained did not confirm his theory that swelling and shrinking take place in the middle lamella which is a pectic substance. It was found that in lignified wood. most of the middle lamella is a lignin substance and that swelling and shrinking take place not there but in the secondary layer of the cell wall. *From author's summary.* [Forestry Abstracts, V. 15, No. 1]

Shrinkage tests [on Beech]. *Rep. For. Prod. Res. Bd., Lond. 1952,* 1953 (13, 14).

Tests were made on samples restricted to 1/8-in. thickness along the grain to minimize the development of stresses during drying. Matched samples were dried quickly or slowly at 6 temperatures. Results so far indicate that shrinkage in slow drying from green to zero moisture content was progressively greater with increasing temperature of drying, but that rapidly dried samples shrank less at high than at low temperatures. Results, shown in graphs, of drying tangentially-cut specimens slowly at 25 and at 70° C. show that: (1) there is a tendency for wood dried at high temperatures to expand in the early stages of drying; (2) shrinkage starts at about 50% m.c.; (3) shrinkage at 70° becomes roughly proportional to the moisture drop from an initial m.c. of about 45%; and (4) shrinkage at 25° becomes proportional to m.c. drop from an original m.c. of about 30%. [Forestry Abstracts, V. 15, No. 1]

Moisture content distribution in wood with one face in contact with water. *Rep. For. Prod. Res. Bd., Lond. 1952,* 1953 (13).

[Cf. *For. Abstr.* 13 (No. 4187).] Tests were made on trays of Douglas Fir and Oak, filled with water for up to 1 year, with the lower faces exposed to air at two different humidities, and with the lower face in one instance coated with bituminous paint. The moisture drop from the wetted face to a depth of about 1/5 the thickness of the wood was very steep and at this depth the moisture content was about 30%. On the exposed surface the m.c. tended to become very slightly higher than the equilibrium m.c. with the surrounding air. Cooting this face with paint appeared to have surprisingly little effect on the general moisture distribution. [Forestry Abstracts, V. 15, No. 1]

Diffusion of water vapour through wood. *Rep. For. Prod. Res. Bd., Lond. 1952,* 1953 (48–9).

The experiments on the flow of water vapour through discs of wood at various temperatures under a relative-humidity gradient of 100% have now been completed. The flow through 12 species in the 3 principal directions was investigated and the results, when reduced to a comparable basis, show that, except in Sitka Spruce, the magnitude of flow through all species and at all temperatures is greatest in the longitudinal and least in the tangential direction. In Sitka Spruce radial flow is slightly less than tangential flow; in other species 2–4 times the tangential flow. In all species the longitudinal flow is about 10–25 times the tangential flow. Temperature has a marked effect on the absolute magnitude of flow, which is approximately doubled in all directions on raising the temperature from 20 to 40° C., as a result mainly of the rise in vapour pressure. [Cf. *For. Abstr.* 13 (No. 4188).] [Forestry Abstracts, V. 15, No. 1]

Moulds, F. R. Comparative strengths of the timber of Californian-grown and South-Australian-grown Monterey Pine (Pinus radiata Don.). *Aust. For.* 16 (2), 1952 (100–4). 2 refs.

A comparison of mechanical properties of specimens of *Pinus radiata* grown in plantations in South Australia and in natural forest in California was made on unseasoned timber. Detailed results are given and the general conclusion reached that only slight differences exist between specimens of similar rate of growth. *Author's summary.* [Forestry Abstracts, V. 15, No. 1]

Huhrjanskii, P. N. Vlijanie vlaznosti na deformacii drevesiny sosny pri pressovanii. [Effect of moisture content on the deformation of Pine wood under pressure.] *Trud. Inst. Les.* 4, 1949 (247–60). 7 refs. [Russ. russ.]

Total and residual deformations were determined for Pine sapwood and heartwood specimens of different moisture content at 10–12° C., and of steamed specimens (m.c. 10–15%) at 80–90°. The results show that, for any degree of compression ⊥ and for any m.c. and temperature, a plastic deformation always accompanies the elastic one. The intermicellar liquid in the wood functions as a lubricant, affecting its internal-friction coefficient. This coefficient decreases as the thickness of the intermicellar liquid film increases and as its viscosity decreases. The lower this coefficient, the less the stress in the wood during compression, and the less its strength. The values of both elastic and plastic deformation during compression depend on the amount and viscosity of the intermicellar liquid. As the amount increases and the viscosity decreases, the elasticity under compression rises and the plasticity decreases. *From author's summary.* [Forestry Abstracts, V. 15, No. 1]

Ivanov, Ju. M., Bazenov, V. A., and Sadovskii, F. F. Opredelenie dinamiceskogo modulja uprugosti drevesiny. [Determination of the dynamic modulus of elasticity of wood.] *Trud. Inst. Les.* 4, 1949 (272–3). [Russ.]

Illustrated description of an apparatus designed in the physics section of the Forest Institute of the U.S.S.R. A wooden rod of standard length is clamped horizontally in a vice fixed to a heavy marble plate; two small iron plates are attached to the rod: one in the middle of its length, the other near the free end. An electromagnet is fixed immediately below each iron plate: the middle one transmits to the rod vibrations from an audio-frequency generator, while the vibrations of the rod are transformed by the second electromagnet into electric vibrations reproduced in a cathode oscillograph. The fundamental frequency is determined by the maximum amplitude. The value of the modulus of elasticity obtained by this method from a known formula corresponds to the static value determined by bending tests. The accuracy claimed is ± 1%, each determination (in a series of determinations), taking ca. 4 min. [Forestry Abstracts, V. 15, No. 1]

Runger, H. G., and Klauditz, W. Uber Beziehungen zwischen der chemischen Zusammensetzung und den Festigkeitseigenschaften des Stammholzes von Pappeln. [Relationships between the chemical composition of Poplar stemwood and its strength properties.] *Holzforschung, Berlin* 7 (2/3), 1953 (43–58). 40 refs. [G.g.e.] P.R.

Investigations were carried out on specimens taken from 3 Poplar hybrids: *Populus 'regenerata grandis', P. marilandica* and *P. 'euramericana* Graffhorst'. The samples for chemical analysis were cut from the early wood of single growth rings, and had, consequently a diameter (or side of the square base) of 1·0 cm. and a height of 1·0 cm. The modified methods for the determination of cellulose, lignin, and pentosans, in samples of ca. 0·08–0·10 g. are described. The mechanical tests (compression and tension) were also made on samples prepared from single growth rings, the moisture content of the samples being usually 10%. The tensile strength was found to depend on the cellulose content; the compression strength, on that of lignin. The presence of tension wood blurs the results, since the over-all increase of cellulose content increases the tensile strength, but the simultaneous reduction of the over-all lignin content reduces the compression strength. The effect of the con-

ten. of pectopolyuronides and of cellulo- on the strength properties is not cl. . Investigations of 1- to 2-year-old Po- ar saplings, exposed to mechanical str. during growth, showed that, while te. on in the direction of growth does no alter the chemical composition of th wood, bending causes a consider- ab formation of reaction-wood with a c. sponding differentiation of chemical c. osition (59·7 and 41·4% cellu- l and 16·4 and 25·7% lignin in th ension-wood and compression-wood z. , respectively). The wet tensile st gth in the tension-wood zone is gr er than that in the compression- w d zone. Investigations on Willow tw s showed that the air-dry wood of 1- ar-old Willows had a greater tensile strength than Poplar wood having an equal or greater cellulose content. [Forestry Abstracts, V. 15, No. 1]

Klauditz, W. Zur biologisch-mechanischen Wirkung des Lignins im Stammholz der Nadel- und Laubholzer.[The biological-mechanical effect of lignin in the stemwood of conifer and broad-leaved woods.] *Holzforschung, Berlin* 6 (3), 1952 (70–82). 65 refs. [G.g.e.] P.R.

(Cf. *For. Abstr.* 12 (No. 1180). [Forestry Abstracts, V. 15, No. 1]

Yamashita, T., and Yonezawa, Y. [Studies on lignin. I. The ultraviolet absorption spectrum of gymnosperm lignin and its analogues.] *Journal of the Japanese Technical Association of the Pulp and Paper Industry, Tokyo* 4 (3), 1950 (9–12). [Jap.] From *Chem. Abstr.* 45 (22), 1951 (10578*f–g*). P.R. [Forestry Abstracts, V. 15, No. 1]

Ranby, B. G. Fine structure and reaction of native cellulose. *Thesis, University of Uppsala* 1952. pp. 22. 80 refs. [E.] [Institute of Physical Chemistry, University of Uppsala.] P.R.

A discussion, based partly on literature and partly on original research on cellulose from *Picea abies* and *Pinus sylvestris*, cotton, bacteria, animals and algae, on dimensions of the micelle strings composing the cellulose fibrils visible in the optical microscope; swelling properties of the micelle strings of the different celluloses in NaOH during mercerization; the effect on them of hydrolysis with hot dilute acid; the colloidal properties of cellulose micelles; the disintegration of pulps in water suspensions by ultrasonic radiation or technical beating; polymolecularity of nati and depolymerized celluloses; and the similarity of algal cellulose from *Valonia* spp. and the dissimilarity of that from *Halycistis* to that from land pla . [Forestry Abstracts, V. 15, No.]

ompson, J. O., Becher, J. J., and W L. E. A physicochemical study of a water-soluble polysaccharide from Douglas Fir (Pseudotsuga taxifolia.) *Tappi* 36 (7), 1953 (319–24). 23 refs. P.R.

Mild cold-water extraction of the heartwood of a 107-year-old Douglas Fir yielded a polysaccharide system in which chromatography revealed the presence of galactose, arabinose, xylose, and traces of acidic material. Osmotic-pressure measurements of the aqueous solution indicated an average degree of polymerization of 340. Hot-water treatment of the residue after cold-water extraction, removed appreciable amounts of carbohydrates, including glucose and mannose. While the pH of the cold-water extract was 7, that of the hot-water extract was ca. 3. [Forestry Abstracts, V. 15, No. 1]

Kohara, J. [Studies on the durability of wood—I. Mechanical properties of old timbers (Horyuji Temple construction timbers, *Chamaecyparis obtusa*).] *Scientific Reports of the Saikyo University, Kyotos Agriculture* 2, 1952 (116–31). 13 refs. [Jap.e.] P.R.

[Cf. *For. Abstr.* 14 (No. 2656); 15 (No. 608).] Presents tabulated and graphed results of comparative tests on *C. obtusa* timber of recent origin and that taken from the 1300-year-old Horyuji temple. For moisture contents of 12–14%, the following results were obtained (the first figure refers to old timber, the second and third to 2 specimens of new timber): sp. gr. 42·2, 37·5, 35·0 lb./cu. ft.; compression strength 454, 308, 313 kg./sq. cm.; static bending strength 717, 641, 635 kg./sq. cm.; Young's modulus 9·13, 7·15, 8·51 ($\times 10^4$) kg./sq. cm.; impact bending 0·26, 0·46, 0·53 kg./sq. cm.; hardness (cross) 4·04, 3·21, 3·11, (edge) 1·10, 0·90, 0·87, (flat) 1·08, 0·81, 0·79 kg./sq. mm.; shear strength 62, 76, 67 kg./sq. cm., and cleavability 12, 17, 16 kg./cm. Old timber shows higher values of compression and static bending strength than new over a m.c. range 0–45%. The % of late wood was 7, 8, 9%; radial shrinkage 2·9, 2·6, 2·4%, tangential shrinkage 4·7, 5·6, 6·1%. [Forestry Abstracts, V. 15, No. 1]

Melehov, I. S. Znacenie tipov lesov i lesorastiteljnyh uslovii v izucenii stroenija drevesiny i ee fiziko-mechaniceskih svoistv. [The significance of forest type and forest growth conditions in research on wood structure and the physical and mechanical properties of wood.] *Trud. Inst. Les.* 4, 1949 (11–20). 22 refs. [Russ.]

Lists 22 Soviet papers on the physical and mechanical properties of wood, in which the effect of the forest type or of growth conditions is taken into consideration. The results obtained are diverse and do not lend themselves to generalization. The need for systematic research in this direction is stressed. As far as the effect of forest type is concerned, the greatest stocks of high-quality Pine in the regions of the north and central *taiga* are found in the *Pinetum cladinosum*. The late-wood/early-wood ratio depends, other things being equal, on the forest type, and so does the mechanical strength of the wood; great differences can also be found in the microscopic wood structure. Besides the soil and climate, the following factors are important: (1) stand composition; (2) 'form' of the stand (i.e. the presence or otherwise of understoreys, their nature, and mutual relationships; (3) age and age structure; and (4) stand density. [Forestry Abstracts, V. 15, No. 1]

Vihrov, V. E. Makroskopiceskoe stroenie i fiziko-mechaniceskie svoistva drevesiny duba v svjazi s uslovijami rosta. [Macroscopic structure and physical and mechanical properties of Oak wood in relation to conditions of growth.] *Trud. Inst. Les.* 4, 1949 (108–31). 11 refs. [Russ.]

Presents the results of studies of 21 sample *Quercus robur* (ca. 60–70 years old) felled in 1946 in 3 plots in the Tellerman experimental forest near the river Khoper. The 3 associations involved were: *Quercetum salinum* (I), *Q. fontinale* (II), and *Fraxineto-Quercetum caricoso-aegopodiosum* (III). The width of growth rings and of late wood, as well as the % of late wood, were much higher for Oaks from II and III than from I. The number/cm. of large rays decreased markedly with height for I, while remaining almost constant for II and III. The strength/density ratios show that, for compression ||, static bending and impact bending, Oak from I is inferior to Oak from II and III, but Oak from all 3 sites of the experimental forest is in nearly all respects superior to the average Pedunculate Oak of Russia in Europe. Oak from III has the greatest density, that from I the lowest. Tables showing the variation of physical and mechanical properties with radius and height are appended for Oaks of the 3 associations. [Forestry Abstracts, V. 15, No. 1]

Sawing

Sawing studies. *Rep. For. Prod. Res. Bd., Lond. 1952,* 1953 (25).

The siliceous timber Makoré [*Mimusops heckelii*] was used in comparative tests, with circular saws, of the performance of 3 types of inserted tooth: standard, treated, and tipped with Stellite. The basis of comparison was the output attainable for % increase in the power requirements of the saw, as this

factor indicates specific degrees of blunting. The tests were made in normal conditions at a fixed feed speed of 40 ft./min. Precision methods were employed to obtain concentricity of the tooth tips so that all teeth were in cut, and shared almost equally in the work. As an example of the performance, for a 25% increase in power, the output from the saw when fitted with standard, treated and stellited teeth was 8, 56, and 3000 linear ft. respectively of 2-in. stock. The edge-life travel in the wood per tooth was, for the 3 types, 52, 400 and 19,400 ft. respectively. Practical tests carried out previously in rather unfavourable conditions in a colonial sawmill had given outputs from standard and Stellite tips in the ratio of about 1:10. The benefit derived from tipping the teeth depends largely upon care taken in preparation and use of the saw. [Forestry Abstracts, V. 15, No. 1]

Wertz, B., and Hrycyk, R. Zuzycie mocy przez trak przy przecieraniu drewna sosnowego. [Power consumption in a vertical frame saw during conversion of Pine logs.] *Sylwan* 97 (1), 1953 (58–65). [Pol.]

The tabulated and graphed results of measurements made with a high-speed frame-saw (continuous feed, stroke 550 mm., inside width of frame 650 mm., kerf width 3·5 mm., long diam. 13·5–46·5 cm., moisture content 28–35%) show a considerable correlation (coefficient 0·9) between the power consumption and the total area of the cut for a single revolution of the spindle at a constant kerf width of 3·5 mm. The results are analysed, using formulae developed by Russian authors, and compared with similar Russian results. [Forestry Abstracts, V. 15, No. 1]

Forsberg, P., and Thunell, B. Undersokning av utbytet vid topp- och rotsagning genom provsagningar utforda vid tva sagverk sommaren 1950. [An investigation on top and butt sawing by test sawings carried out in two sawmills during the summer of 1950.] *Medd. svenska Träforskninst. (Trätekn. Avd.)* No. 30*B*, 1952. pp. 46 + 4 photos + many dgms., gphs., tbls. [Sw.] P.R.

Test sawings were carried out in two gang-saw mills, one normally sawing with the butt end, and the other with the top end first. Logs were sorted into top diameters 6, 8, 10 and 12 in., and 300 logs of each dimensions were sawn by each method. In each mill, sawing by the unfamiliar method reduced the yield of sawn timber, by 2·3% in the change to top end first and by only 1·7% for butt end first, but the reductions in quality of sawn timber obtained with the latter largely offset the 0·6% difference between the 2 methods; there was a corresponding increase in the yield of chips from slabs and edgings, and of sawdust when the unfamiliar method was used. It is concluded that there is little difference in yield between the two methods. Before sawing, total volumes of the logs were estimated by methods based on mid-diameter, top-butt diameter and floating volume according to the Angermanälv volume tables. The three methods gave similar results for the smaller logs, but considerable differences for the larger ones. Mid-diameter measurements gave volumes closest to the total timber volume actually obtained and, like the floating volume, rather below it, while the top-butt diameter measurements gave volumes above those obtained for the 10- and 12-in. logs. [Forestry Abstracts, V. 15, No. 1]

Veneers and Plywood

Matson, E. E. Lumber grades from Douglas Fir peeler logs. *Res. Note Pacif. Nthwest. For. Range Exp. Sta.* No. 83, 1952. pp. 5.

Gives figures in tables and graphs showing lumber grade recovery from grades 1, 2 and 3, based on recovery studies at mills in the Eugene area, Coos Bay area and in southern Oregon. [Forestry Abstracts, V. 15, No. 1]

Perry, T. D. Veneer and plywood machinery. Part 2. Veneer lathes and reeling equipment. *Wood Working Digest* 55 (4), 1953 (121–4, 126, 128–32). P.R.

An illustrated description of modern veneer lathes, secondary lathes for cores, lathes for packaging veneers, and reeling units. [Forestry Abstracts, V. 15, No. 1]

Kollmann, F., and Geschwandtner, H. Betriebsmessungen an Furnierschalmaschinen. [Service measurements on veneer peeling machines.] *Holz Roh- u. Werkstoff* 11 (5), 1953 (182–90). 6 refs. [G.g.] P.R.

Presents graphed and tabulated results of measurements in 6 German veneer plants on the relationships between power consumption and the factors: number of revolutions (angular speed), cutting speed, log length, veneer thickness, cutting angle, compression of wood (nose-bar adjustment), pre-treatment of logs, species, type of driving gear, and speed control. Discusses the effect on veneer quality of the adjustment of the peeling machine [cf. *For. Abstr.* 12 (No. 464).] The power consumption required varies with local conditions. During the peeling process, consumption falls from an initial peak value, decreasing up to the end of the process. [Forestry Abstracts, V. 15, No. 1]

Irschick, E. Das 'Stehvermogen' von Sperrplatten. [The resistance of plywood sheets to warping.] *Holz-Zbl.* 76 (93), 1950 (1017–8). [G.]

Analyses the causes of, and gives advice how to prevent, the various forms of warping in plywood sheets. [Forestry Abstracts, V. 15, No. 1]

Laminated shapes. *Bull. Aero-Res., Duxford* No. 120, 1952. pp. 7. P.R.

Some notes on methods for producing laminated bends in wood. [Forestry Abstracts, V. 15, No. 1]

Utilization

Guernsey F. W. Utilization of sawmill residue in the southern coast region of British Columbia. *Bull. For. Br. Can.* No. 109, 1953. pp. 31.

A survey of the amount of wood waste available, present utiliaztion and possible future uses. [Forestry Abstracts, V. 15, No. 1]

Bell, G. E. The use of sawmill waste for pulp in Eastern Canada. *Bull. For. Br. Can.* No. 108, 1953. pp. 48.

Consists mainly of notes (illustrated) on various types of barker and chipper suitable for use on slabs and edgings and destined for pulp manufacture, and methods of transporting waste. [Forestry Abstracts, V. 15, No. 1]

Knauss, A. C. Utilization of mill residues in the timber products mills of the Lakeview working circle [Oregon]. *Res. Pap. Pacif. Nthwest. For. Range Exp. Sta.* No. 6, 1953. pp. 14. 1 ref.

Gives figures for production and actual utilization of wood waste from 4 sawmills and 3 remanufacturing plants, and discusses potential uses. [Forestry Abstracts, V. 15, No. 1]

Egund, K. F. Brikettering av traeaffald. [Briquetting wood waste.] *Traeindustrien* 3 (7), 1953 (73–80). 24 refs. [Dan.] Also in *Norsk Skogind.* 7 (7), 1953 (231–8). [Dan.e.]

Discusses data, drawn mainly from Danish and American experience, on the effect of pressure, temperature, moisture content, particle size and addition of adhesives, on tensile strength of briquettes and their cohesion during transport, storage and heating, and describes a number of European and American presses. [Forestry Abstracts, V. 15, No. 1]

Wood Floors

Gratzl, A. Holzfussboden in Theorie und Praxis. [Wooden floor in theory and practice.] *Mitt. öst. Holzforsch.* 4 (6), 1952 (135–45) 19 refs. [G.] P.R.

Discusses the consumption of wood for flooring in Austria, Germany and Switzerland. Enumerates the requirements for flooring woods, and describes the testing machine developed, and some of the wood tests carried out, at Princes

Risborough. The usual flooring methods (strip floors, ship planking, overlay flooring, parquet flooring, wood paving brick, decorative parquet flooring), and new developments (mosaic parquet, panels with wood veneers, lamellar strip flooring etc.) are described, and methods of laying and maintenance of floors discussed. [Forestry Abstracts, V. 15, No.]

Kuhle, E. Parkettmaschinen. [Parquet machines.] *Holz Roh- u. Werkstoff* 11 (6), 1953 (216–23). 2 refs. [G.g.] P.R.

Analyses the successive stages of flooring-strip manufacture in Germany, and gives illustrated descriptions of the design and operation of various machines of German manufacture. [Forestry Abstracts, V. 15, No. 1]

Kuhle, E. Entwicklungs- und Erzeugungs-probleme von Mosaikparkett. [Development and manufacturing problems of 'mosaic' parquet.] *Holz-Zbl.* 79 (90), 1953 (987–8). [G.]

Appraises the Swiss mosaic parquet manufactured in square panels (48 cm. side) composed of 16 small squares, each of which contains 5 wooden strips 12 × 2·4 × 1 cm., the direction of the strips in the adjacent squares being at right angles to each other. Comparison with 'solid' strip parquet is made mostly from the point of view of cost and saving of material. Briefly describes mosaic-parquet manufacture with particular reference to seasoning. Recent practice takes curves of the m.c. frequency distribution for each kiln and each seasoning batch in order to ascertain the quality of the product. [Forestry Abstracts, V. 15, No. 1]

Fussboden aus deutscher Douglasie. [Flooring from German-grown Douglas Fir.] *Holz-Zbl.* 79 (5), 1953 (29). [G.]

Douglas-Fir strips are usually laid when all other work has been completed (even whitewashing, painting, paperhanging, and all lighting installations, including the hanging of lamps); the strips are then thrice impregnated with hot linseed oil. [Forestry Abstracts, V. 15, No. 1]

Liiri, O. Puulattiain kulutuskestavyydesta. [The resistance to wear of timber flooring.] *Pap. ja Puu* 35 (6), 1953 (269–72). 10 refs. [Fi.] P.R.

A review of European and American research. [Forestry Abstracts, V. 15, No. 1]

Preservation

Report of Committee P-4, New preservatives. *Proc. Amer. Wood Pres. Ass.* 48, 1952 (115–20). P.R.

Contains a revised standard method for the determination of pentachlorophenol in oil or wood, and a method of determining the penetration of solvent used with oil-soluble preservatives. The following changes in the names of preservatives are recommended, the new names being given in brackets: Boliden salt (chromated zinc arsenate); Celcure (acid copper chromate); Chemonite (ammoniacal copper arsenate); Copperized CZC (copperized chromated zinc chloride), and Greensalt (chromated copper arsenate). [Forestry Abstracts, V. 15, No. 1]

Schuch, K. Zur Methodik der Fluorbestimmung in der Holzschutzforschung. [Method of determination of fluorine in wood preservation research.] *Holzforschung, Berlin* 7 (1), 1953 (18–25). 15 refs. [G.g.e.] P.R.

Describes in detail a reliable method of determining F in wood, based on the fundamental research of Willard and Winter [*Industr. Engng. Chem. (Anal. Ed.)* 5, 1933 (7–10).] [Forestry Abstracts, V. 15, No. 1]

Investigations into the effect of sodium fluoride on concrete, various metals and wood glues. *Aust. Timb. J.* 19 (4), 1953 (286). 1 ref.

When concrete and metals were immersed in 1% NaF solution and boiled daily for 3 hours over a period of 5 months, concrete showed no loss of weight or apparent deterioration, brass and copper were not unduly corroded (0.1–0.2% loss of weight) but galvanized iron and mild steel were corroded (1–3% and 4–7% loss respectively) and pitted. Urea formaldehyde, animal and casein glues behaved satisfactorily when used to bond solid timber containing 0.4% NaF. All tests of Tego bonded panels from fluoride-treated veneers were satisfactory except the weathering test. [Forestry Abstracts, V. 15, No. 1]

Simon, A., and Tonjes, H. Beitrage uber das Verhalten von Natriumpentachlorophenolat als Holzimpragnierungsmittel. [Behaviour of Na pentachlorophenate as a wood preservative.] *Holz Roh- u. Werkstoff* 11 (3), 1953 (104–11). 11 refs. [G.g.] P.R.

Describes a quantitative method of determining Na pentachlorophenate and a method for its detection. Its penetration in aqueous solution into wood has been evaluated by a number of known methods, and a method of estimating its penetration from pastes has been developed. It has been found that it diffuses in chromatographic paper just as readily as NaF. Its solubility in water is given for different temperatures. Evaluation of its leachability and leaching rate from impregnated wood blocks (conducted according to DIN 52176, sheet 2) shows that, in spite of its ready solubility in water, ca. ⅓ is not leached out; the washings contain more of the Na^+ than of the pentachorophenate ion. It is impossible to secure additional fixation by using CO_2, as the reaction involved is reversible. [Forestry Abstracts, V. 15, No. 1]

Walters, C. S. The effects of copper naphthenate and pentachlorophenol on livestock. *Proc. Amer. Wood Pres. Ass.* 48, 1952 (302–13). 7 refs. P.R.

Results of tests on pigs, sheep and cattle show that, under the conditions of experiments, none of the livestock tested showed any visible effects from the use of treated housing or feeding equipment or fencing material. Experiments in which pigs and sheep were drenched with the chemical solutions point to the possibility of a noxious effect, and a set of precautions are given to preclude any harm being done to livestock by the use of Cu naphthenate or pentachlorophenol. [Forestry Abstracts, V. 15, No. 1]

Seasoning

Kiln seasoning [of imported hardwoods]. *Rep. For. Prod. Res. Bd., Lond. 1952,* 1953 (11).

The presence of tension wood had caused partly-dried Andiroba [*Carapa guianensis*] to become badly distorted, but by careful stacking, weighting and steaming the load at high temperatures initially and finally, the kiln-dried material was in much better shape than before seasoning. Bisselon [*Khaya senegalensis*] dried as well as the less dense African Mahogany [*K. ivorensis?*]. One-inch Obeche [*Triplochiton scleroxylon*] dried very satisfactorily under a much more severe schedule than had been recommended, in just under 4 days. Experimental loads of Kurokai [*Protium decandrum*], Wamara [*Swartzia calycina*] and Alstonia [*A. congensis*] proved refractory, except Alstonia. [Forestry Abstracts, V. 15, No. 1]

Egner, K. Zur Steuerung der kunstlichen Holztrocknung. [Control of artificial seasoning.] *Holz-Zbl.* 79 (83), 1953 (911–3). 5 refs. [G.]

An illustrated description of different instruments used for the measurement of air temperature and humidity in kilns, and moisture content of wood (both inside and outside the kiln) with special reference to resistance-type electrical moisture meters. [Forestry Abstracts, V. 15, No. 1]

Technische Neuheiten. Der Einfachst-Trockner 'Orkan'. [Engineering news. The simple 'Orkan' kiln.] *Holz-Zbl.* 79 (40/41), 1953 (474–5). [G.]

Illustrated description of a 'longitudinal-air-current', unheated, timber-drier. The boards are arranged longi-

tudinally on special aluminum shelf-laths (stickers) so as to form a stack of square section, held firmly between 2 corrugated-iron or other sheets topped with a transverse sheet. The 3 sheets are held together by a few clamps, and form a channel through which air is either blown or sucked by a powerful fan arranged at one end, the air speed reaching 12m./sec. Softwood boards 24 mm. thick with m.c. above the fibre-saturation point are claimed to lose 1.3% per hour when the outdoor temperature is 4–15° C. A graph shows that 1-in. green Spruce, unedged, has been dried from 86% to 18% m.c. within 63 hours, the energy consumption being 0.8KWH/kg. removed water, at between 4° and 15°. [Forestry Abstracts, V. 15, No. 1]

Eisenmann, E. Leistung und Wirtschaftlichkeit neuer Holztrocknungsverfahren. [Ouput and economic aspect of new wood-seasoning methods.] *Repr.* from *Holz-Zbl.* 78 (76), 1952 (1090–2). [G.]

An illustrated description of the construction and operation of (1) a transverse condensation-type kiln, and (2) a hydro-extractor with spiral air circulation [cf. *For Abstr.* 13 (No. 1674)] both of the author's design, said to embody the advantages of both the orthodox low-temperature (ca. 65° C.) kilns and those working at temperatures over 100°. Kiln (1) has thermal insulation on all walls and ceiling, electric heating elements near the ceiling, one or more fans forcing the air through the heaters to the timber stack, a condensation plate and a condensation-water trough along the floor on the side farthest from the heating elements, with a single heating element above it. Air coming from the stack towards the condensation trough is unevenly loaded with water vapour, but its relative humidity becomes uniform by passing over the condensation trough with its longitudinal heating element. It is claimed that a kiln of this kind, of 7 cu.m. capacity, is capable at 90–110° of drying 25-mm. Pine timber from 50 to 7% m.c. at a rate of 4%/hour, while Beech 40 mm. thick, when dried at not more than 90°, lost 1%/hour from 40 to 8% m.c. Seasoning costs per 1 cu.m. coniferous wood 24 mm. thick for drying from 35–40 to 8% m.c. amount to DM. 8–15 for ordinary kilns, DM.6–10 for high temperature all-iron kilns, DM.5.5–7 for transverse condensation type kilns, and DM.5 for hydro-extractors. [Forestry Abstracts, V. 15, No. 1]

Pulp and Paper

Congress issue prepared for the symposium on the chemistry of wood and wood constituents being held in Stockholm, July 29–August 3, in connection with the XIIIth International Congress of pure and applied chemistry. *Svensk PappTidn.* 56 (14), 1953 (509–64.) P.R.

Contains the following papers, all in English: The history of the first industrially manufactured sulphite pulp and its introduction into the paper trade market (*G. Spaak*); Some Swedish contributions to wood chemistry: a brief historical survey (*E. Adler*); Characteristic features of modern Swedish cellulose industry (*L. Stockman*); The development of Swedish forest products research (*T. Bergek*); Dissolving wood pulps (*W. L. Améen*); Present tendencies in the development of pulp bleaching (*J. Richter*); The origin and development of the defibrator process (*A. Asplund*); and the Swedish wood pulp industry [giving details of the different mills manufacturing chemical pulp] (*S. Westerberg*). [Forestry Abstracts, V. 15, No. 1]

Runkel, R. O. H. Pulp from tropical woods: historical development and results of a research work 1925–1952. *Mitt. Bundesanst. Forst- u. Holzw.* No. 29, 1952. pp. 85 + 73 photos and gphs. 103 refs. [E.e.]

A comprehensive survey of work by the author and others on pulping of tropical woods, the effect of wood anatomy and chemistry on pulp, and mechanical and physical properties of pulp from different tropical species and mixtures, using different pulping methods. [Forestry Abstracts, V. 15, No. 1]

Wegelius, T. Aktuella problem vid ravaruanskaffning och -hantering. [Present problems in obtaining and treating raw materials [for the pulp industry].] *Pap. ja Puu* 35 (7), 1953 (279–84). [Sw. e.] P.R.

Discusses the possibility of using waste wood and thinnings to reduce costs, the use of portable chippers and mill barking machines, and the value in Finland of such methods as the 'Chemigroundwood' process [cf. *For. Abstr.* 12 (No. 525–5)] and the new 'Vapurge' process of the Pulp and Paper Research Institute of Canada. This process, which includes pretreatment of chips and rapid cooking (sometimes only 20 minutes) has given good results both with kraft and $NaHSO_3$ cooks, with mixed species (50% Jack Pine, 25% Aspen and 25% Birch), with mixtures of stored and fresh wood, and in the production of corrugating board from straw. [Forestry Abstracts, V. 15, No. 1]

The Va-Purge process in chemical pulping: a symposium presented at the summer meeting of the Technical Association, Canadian Pulp and Paper Association, held at Saranac Inn, New York, June 4–6, 1953. *Pulp Paper Mag. Can.* 54 (8). 1953 (97–134).

Contains a number of papers (referenced individually). and discussion, on the new process. [Forestry Abstracts, V. 15, No. 1]

Runkel, R. O. H., Schambach H., and Witt, H. Uber den Einfluss der Temperatur bei der Herstellung von Halbzellstoffen aus Laubholzern im alkalischen Verfahren. Erste (vorlaufige) Mitteilung. [Effect of temperature on the manufacture of semichemical pulp from broadleaved species in the alkaline process. First (preliminary) communication.] *Holzforschung, Berlin* 7 (1), 1953 (9–12). 3 refs. [G.g.c.] P.R.

Semichemical pulp obtained by mild alkaline treatment (10% of NaOH) of Beech, followed by grinding, was tested for brightness and strength, the digestion temperatures being 20, 70, 100, and 150° C. The lowest of these temperatures yields a very bright pulp, and the pulp obtained by treatment at 100° has a very high tearing strength. [Forestry Abstracts, V. 15, No.]

Sawada, H. The neutral sulfite semi-chemical pulping of Beech. *Journal of the Japanese Technical Association of the Pulp and Paper Industry. Tokyo* 5, 1951 (211–9). [J...e.] From *Chem. Abstr.* 45 (22), 1951 (10577*d-e*). P.R. [Forestry Abstracts, V. 15, No. 1]

Building boards from bark-sawdust-paraformaldehyde mixtures. *Aust. Timb. J.* 19 (4), 1953 (293 . . . 297).

Satisfactory boards were obtained from *Pinus radiata* bark and sawdust and from *Eucalptus crebra* bark with mixed hardwood sawdust. Optimum pressing conditions were 300 lb./sq. in., 130° C. and 6 min. A moisture content of 17·5% for the mixture before pressing seemed to give the best results, but with *P. radiata* mixtures up to 5% m.c. could be used when the boards were allowed to mature. Figures for the effect of m.c. on board properties are given in graphs. As little as 20% bark content gives boards with good strength properties; these increased with bark content up to 80%. [Forestry Abstracts, V. 15, No. 1]

Board Products

Production of fibreboards from secondary colonial timbers. *Rep. For. Prod. Res. Bd., Lond. 1952,* 1953 (40–1).

A method of extraction in simple apparatus with alcohol vapour removes practically all the alcohol-soluble material from full-size cooking chips of Wallaba [*Eperua* sp.] in a short time. Boards of high strength (modulus of rupture 10,000–11,000 lb./sq. in. are

prod.ced; their water absorption is consider.bly higher than that of boards mad. from unextracted wood but small addi.ons of rosin size to the pulp dim.sh it. Boards with water-absorption ..lues low enough to comply with the .quirements of *Brit. Stand.* 1142 (D Revision CM (TIB) 8131) have also been made by incorporating sma quantities of wax emulsions. Both me.ds of sizing caused slight strength loss. but boards were still above the spec.fied minimum value for modulus of .ture. Prolonged heat treatm.nt after pressing considerably improved the water resistance of unsized boards with.ut loss of strength properties, but so f.r the wax-emulsion treatment has prov.d more reliable. [Cf. *For. Abstr.* 14 (No. 1716).]

Morabukea [*Mora gonggrijpii*], although hard and of high density (60–65 lb./sq. in.) gave satisfactory pulping chips, best results being obtained with wood at a moisture content of not less than 34–45%. Board of satisfactory strength (modulus of rupture 8,000–10,000 lb./sq. in.) and of pleasing appearance have been made by using a cooking schedule similar to that for Wallaba. Water-absorption values, as high as or higher than those for extracted Wallaba, could be reduced to meet the specified requirements for standard hardboard by small additions of a proprietary wax-emulsion size. Similar results to those for Wallaba were obtained by heat treatment.

In experiments on the practical lower limit of chemical consumption, using Morabukea chips, satisfactory results were obtained with a consumption of 5% Na_2SO_3 and 2·5% $NaHCO_3$ (based on dry weight of wood). Cooking for 1 hour at 180° C. was sufficient, and pressures of about 200 lb./sq. in. were maintained in the digester owing to the combined effect of steam and CO_2 produced during the reaction. Boards from pulps cooked with less than 5% Na_2SO_3 were insufficiently strong even when the pH of cooking liquors was kept up by adding other alkalis. Similar results are expected for Wallaba. It is thought that a disc mill will be more efficient than a beater for defibering the cooked chips and may further reduce consumption of chemicals. [Forestry Abstracts, V. 15, No. 1]

Mil, **M. Studies on hardened fiberboards. VII. Beating in the manufacture of groundwood fiberboards by the wet process. IX. Chemical treatments of groundwood fiberboards [manufactured] by the wet process [: a substitute for rosin soap and paraffin as the waterproofing reagent].** *Wood Industry* [, *Japan*] 6, 1951 (350–3; 459–62). From *abstrs.* in *Rec. Res. Fac. Agric. Univ. Tokyo* No. 2, 1951/52 (1953), (77–8). [E.] [Forestry Abstracts, V. 15, No. 1]

Barking

Cook, D. B., and Hamilton, L. S. Chemi-peeling pulpwood in New York. *J. For.* 51 (8), 1953 (566–9). 8 refs.

Reviews present practice and some of the literature on the chemical treatment of trees to facilitate barking, with notes on the treatability of the principal New York pulpwood species. [Forestry Abstracts, V. 15, No. 1]

Jahn, E. C. Chemical debarking of trees. *Sth. Lumberm.* 187 (2336), 1953 (41–2).

Summarizes a study sponsored by a group of companies and carried out by a research team at the New York State College of Forestry, Syracuse University. Studies so far indicate that 40% Na arsenite solution is the most effective chemical. A peelability gauge developed by the team measures the force required to turn a disc of bark of a given diameter on the tree. Recommendations are made on method of application, and date and weather for treatment. Spruce, Balsam Fir, Hemlock, Scots Pine, Beech, Elm, Hard Maple, Red Oak, Cherry and Aspen reacted especially well to chemical treatment, as do, apparently, dominant and co-dominant trees and those of good growth vigour. Diameters between 8 and 17 in. gave good results, trees above and below these limits tending to peel less well. The period of good penetration of the chemical into the tree coincides with that of best natural peeling, middle to late May to June. A large part of the chemical reaches and remains in the bark and leaves. If the girdle is unscored or uncut there is very little depth of penetration, almost all the chemical remaining in the outer part of the wood and bark. If the sapwood is scored or cut there is greater penetration. The movement of As away from the girdle face, studied by radioactive isotopes, was very rapid from unscored girdle faces, 95% being gone in 48 hours with Spruce, and more gradual if the sapwood has been cut or scored. Any danger to wild life occurs in the first 72 hours. Brightly coloured dyes should be avoided, and precautions taken against spilling. Preliminary evidence indicates that creosote and Permatox B may repel deer, other repellents being ineffective. Best results in barking are obtained if treated trees are allowed to stand through the winter. Pulps from treated wood are equal in quality to those from untreated wood and the As content in pulps and papers is from 0 to 2 p.p.m., rates which have been found in some pulps from untreated wood. [Forestry Abstracts, V. 15, No. 1]

Novak, V. Vyzkum rychleho chemickeho odkornovani dreva. [Experiment on rapid chemical barking of wood.] *Lesn Práce* 32 (4), 1953 (155–9). [Cz.]

The development of barkbeetles and wood-borers on stems treated chemically in order to accelerate barking is described in some detail. Out of a total number of 52 Spruce stems of felling age, 10 were treated once only with an As [+ NaOH?] compound, this [solution?] being rubbed into the wood exposed by girdling; 24 had double treatment; 11 had the same compound injected, while the remainder were untreated controls, some of them girdled. Preliminary laboratory tests showed that the compound, used as stomach poison at 0·08 – 1·30 mg. c.c. concentration, effected a 50–80% kill of barkbeetles during the first week and a 100% kill during the second. As a contact poison (37·8% As) it killed them in 15–30 min.

The stems were treated in mid-May. It was found that, where the substance had been distributed uniformly, an abnormal or reduced development of the insect occurred in the cambium, the abnormality showing in the dimensions of the mother tunnels, the direction of the larval tunnels, appearance of the frass etc. The injection treatment did not yield good results because the distribution of the chemical was not uniform. Single treatment by rubbing killed 10% of barkbeetles and larvae in the trees after 1 month, and 100% of *Ips typographus* in all stages after 4 months [the % kills are based on total population in the trees of the insect specified]; yet *Pityogenes chalcographus* showed only a 25% kill after 5 months. Stems treated twice gave, after 2 months, an 80% kill of *Ips typographus* larvae, and a 50% kill of all stages of *P. chalcographus* (80% a week later); after 4 months all stages of both species showed a 100% kill. The kill of *Polygraphus polygraphus*, whose tunnels are remote from the poisoned cambium, was only 20% after 4 months, and 50% after 5 months. All the above results relate to stems that were attacked after the treatment. When the attack preceded the treatment, the efficacy of the poison was much reduced, since it could not penetrate well

into the tunnels. It is noteworthy that the natural enemies (predators and parasites) of the beetles were not poisoned by the chemical used; and that the attacking insects avoided the sections of wood coated with the poison. [Forestry Abstracts, V. 15, No. 1]

The 'Mira' barker: a new Swedish portable machine. *Pulp Paper Mag. Can.* 54 (9), 1953 (152, 156).

Describes with illustrations the new barker, made by C. J. Wennbergs Mekaniska Verkstad, Karlsberg, and Paper Mill Equipment Limited, Montreal. The standard machine barks logs from 2 to 12 in. diam., and a machine for barking logs up to 20 in. diam. has been designed. Barking is done by 3 scrapers mounted on a drum which rotates at a constant speed of 275 revs./min. Pressure of the barking tools against the log is applied through spring-loaded counterweights. The bark is thrown out by fanblades on the barking tool. Feeding, by 8 feeding rolls, is at a rate which can vary from 30 to 100 ft./min. Trials have shown that cutting into the wood is prevented and wood loss is negligible. The machine has been used satisfactorily for Fir, Spruce, Birch, Poplar, Larch and even for water-logged timber, and with excellent results on winter-felled timber and autumn-felled timber stored in the open. [Forestry Abstracts, V. 15, No. 1]

Reissinger, G. Der Leichtmetallkeil. [The light metal wedge.] *Forstarchiv* 23 (5/6), 1952 (107–8). [G.g.]

Describes, with photographs, a wedge of the author's design, made by the Dürener Metallwerke, Düren Rheinland, and consisting of: (*a*) a pressed duralumin wedge-piece—angle 11·5°, length 190 mm., breadths at 5 and 15 mm. from the working edge respectively 58 and 70 mm., edge thickness 0·5 mm., weight 525 g.; socketed to receive (*b*) a wooden, metal-bound striking heel weighing 545 g. For safety when working on frozen wood the wedge piece has 3 small perforations near the working edge: if ends of wire are inserted into these, they will anchor in the frozen wood and prevent the wedge from jumping back. As the wires are free to pivot at their insertion in the wedge, they are no hindrance if the wedge has to be freed by rocking it from side to side. There is little risk of damage to saws, as the duralumin is much softer than the saw teeth. The wedge is said to have withstood severe conditions of use completely satisfactorily, and to have a long working life. [Forestry Abstracts, V. 15, No. 1]

Equipment news. *Unasylva* 7 (2), 1953 (84–6).

Descriptive notes, with photographs, of the following among others: portable fire pump (McCulloch Motors Corp., 6121 West Country Blvd., Los Angeles 45, U.S.A.); portable brush grinder (Model No. 3) for grinding branches, tree trimmings and brush into small wood chips (Mitts and Merrill Inc., Saginaw, Mich., U.S.A.); Mandator Mark III tractor with trailer or semi-trailer for hauling tree-length logs (A. C. V. Sales Ltd., 49 Berkeley Square, London W.A.); Model MK26 truck and trailer (Maschinenfabrik, Augsburg-Nürnberg A.G. (M.A.N.), Katzwangerstrasse 100, Nürnberg 24, Germany); heavy-duty logging truck (Hayes Mnfg. Co. Ltd., 225 West Second Avenue, Vancouver, Canada); Radyne (Model H25/W), Radio-frequency glue-setting equipment (Radio Heaters Ltd., Wokingham, Berks, England); crosscut saw 1 6in. (41 cm.) Type H.C.S. designed for sustained production work (W. Kellam & Co., Bath Street Works, Belgrave, Leicester, England). [Forestry Abstracts, V. 15, No. 1]

Wood Research

Moskaleva, V. E. Metodika issledovanija stroenija drevesiny v otrazennom svete. [Method of investigating the structure of wood by reflected light.] *Trud. Inst. Les.* 4, 1949 (80–4). 2 refs. [Russ.]

Describes the use of microscopy in reflected light when sections for transmitted light cannot be easily obtained. An opaque-illuminator, epi-condenser, or the standard metallographic microscope can be used. Specimens of compressed wood were prepared in the same way as metallographic specimens, by consecutive polishing with finer and finer emery paper and woollen cloth. Lignostone was cleanly cut with a sharp chisel and examined under a low-power binocular microscope, followed by an examination through a standard microscope in reflected light. The use of reflected light enhances the unevenness of surface, all projecting elements being very bright. The photomicrographs show zones of failure in compressed Pine wood and Lignostone, fracture of (Birch, and Spruce) charcoal, and a vessel in the wood of Lime. [Forestry Abstracts, V. 15, No. 1]

Chattaway, M. M. The occurrence of heartwood crystals in certain timbers. *Repr.* from *Aust. J. Bot.* 1 (1), 1953 (27–38 + plates). 2 refs. (*Repr. For. Prod. Aust.* No. 181).

Crystals of very characteristic shape and colour have been observed in the heartwood of 52 hardwood species from 19 different families. They do not resemble the CaC_2O_4 crystals commonly found in many timbers and have never been found in sapwood. They appear first in ray cells, when these are in contact with a vessel element, and are frequently found in close association with fungal hyphae. An intensive study of the crystals in *Eucalyptus hemiphloia* and *E. sideroxylon* showed that they occur from the pith to a short distance from the outer edge of the heartwood, and from the base of the tree to the upper limit of the heartwood. The distribution in other *Eucalyptus* spp. appears to be similar. Crystals from *E. hemiphloia,* when examined by partition chromatography, gave chromatograms identical with those of ellagic acid, and it is probable that the crystals in other Myrtaceae are of a similar nature. Further research is needed in order to identify the associated fungi and to determine the chemical composition of the crystals, and that of the heartwood extractives of woods in which they occur. [Forestry Abstracts, V. 15, No. 1]

Bazenov, V. A. K voprosu o linijah skoljzenija vo vtoricnom sloe kletocnyh obolocek. [Slip lines in the secondary cell wall.] *Trud. Inst. Les.* 4, 1948 (168–73). 4 refs. [Russ.russ.]

Observations in polarized light reveal minute slip lines in both collapsed and non-collapsed wood. Microscopic investigation of the development of collapse in tracheid walls shows that the places of failure are defined by the direction of the slip lines. The fine slip lines develop into large ones, and the latter into failure. It has been found that, beyond the limit of plastic flow, the slip lines are observable on thicker sections, while below the limit of plastic flow they are better visible on thin sections. The angle of inclination of slip lines in the early wood is much greater than in late wood; for Pine the respective figures are 19·2° and 17·3°. *From author's summary.* [Forestry Abstracts, V. 15, No. 1]

Campredon, J. Le bois de reaction, veine rouge, cellules gelatineuses. Leurs caracteres, leur influence sur l'utilisation du bois. [Reaction wood, compression wood, gelatinous-walled fibres [tension wood]. Their characteristics, and their effect on wood utilization.] *Rev. Bois Appl.* 8 (2), 1953 (3–7). 4 refs. [F.]

Discusses the formation, structure, and properties of the compression wood of conifers, and tension wood of broad-leaved species. [Forestry Abstracts, V. 15, No. 1]

MISCELLANEOUS

ropical timber: production and co-umption prospects. Organization for European Economic Co-operation, Pa-s, 1953. pp. 68.

port of a committee of experts wh-h has considered replies from a nu-er of countries to questionnaires on increasing the use of tropical hardw-ds. The report, a sequel to an earlier on- [cf. *For. Abstr.* 12 (No. 2964)], co-tains chapters on: Production of tro-ical timber; Consumption of tropical timber; Cost-price calculation; Price co-parison between tropical and non-tropical species; Names of species, grading rules, and standardization; and Annexes; Statistics on export of some overseas territories; Final uses of tropical timber in some member countries; Swiss memorandum on tropical timber. [Forestry Abstracts, V. 15, No. 1]

MacGregor, J. J. World timber and pulp—requirements and supplies. *World Crops* 5 (3), 1953 (93–7). O.R.E.

Discusses factors affecting world requirements and supplies during and after the war and the work of FAO and ECE, and reviews the state of the markets and problems of the post-war era. [Forestry Abstracts, V. 15, No. 1]

Klauditz, W. Vorrichtung zur Entnahme von Holzproben aus stehenden Baumen fur Untersuchungszwecke. [Device for taking wood samples for tests from standing trees.] *Holz Roh- u. Werkstoff* 11 (6), 1953 (211–2). 2 refs. [G.g.] P.R.

The device (illustrated) consists of a manually operated hollow drill mounted in a frame that can be firmly attached to the tree. The wood samples (cores) extracted are 57 mm. in diam. and up to 43 cm. long. [Forestry Abstracts, V. 15, No. 1]

Pfeifer, J. R. Western hardwoods—a promising industry. *Repr.* from *National Hardwood Magazine, Memphis, Tenn.* March, 1953. pp. 4.

Includes tables showing available supplies, working properties and strength properties of a number of species, including *Alnus rubra, Acer macrophyllum, Arbutus menziesii, Castanopsis chrysophylla, Fraximus oregona, Lithocarpus densiflorus, Quercus garryana, Q. kelloggii* and *Umbellularia californica.* [Forestry Abstracts, V. 15, No. 1]

Tamesis, F., and Aguilar, L. Important commercial timbers of the Philippines, their properties and uses. *Popular Bulletin, Department of Agriculture and Natural Resources, Republic of the Philippines, Manila* No. 32, 1951. pp. 83 + 5 plates.

Contains: (1) General notes on timber; (2) information on 65 Philippine species, their distribution, availability, size, and general features of the wood; (3) short sections on the physical properties of timber and on seasoning; (4) uses of timber, with a classification showing the species most suitable for different purposes; (5) a classification of Philippine trees into 4 groups for the purpose of collecting royalty on trees felled in the public forests; and (6) information on weights, strength properties and durability of Philippine timbers. [Forestry Abstracts, V. 15, No. 1]

NORTHERN HARDWOOD VENEERS

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Random & Dimensions Widths —Lengths to 100"

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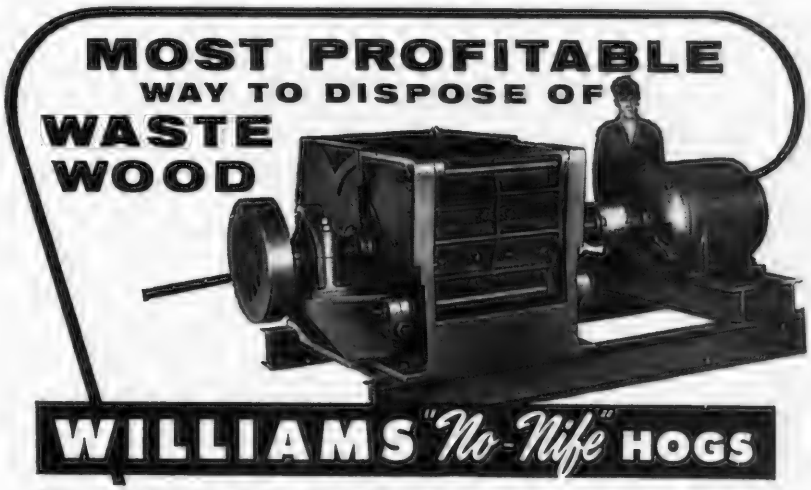

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Draper Corp., Hopedale
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The Dow Chemical Co., Midland
Everett Piano Co., South Haven
The Lloyd Manufacturing Co., Menomine

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Rilco Laminated Products, Inc., St. Paul
Wabash Screen Door Co., Minneapolis

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Monsanto Chemical Co., St. Louis

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NEW YORK
American Defibrator, Inc., New York
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Peter Cooper Corps., Gowanda
Oval Wood Dish Corp., Tupper Lake
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NORTH CAROLINA
The Champion Paper & Fiber Corp., Car
Deluxe Saw & Tool Company, High Po

OHIO
The Baker Wood Preserving Co., Colun
The Baldwin Co., Cincinnati
Buckeye Screen & Weatherstrip Co., Colu
Coe Manufacturing Company, Painesvill
The Kirk & Blum Mfg. Co., Cincinnati
Moraine Box Company, Dayton

OREGON
Cascades Plywood Corporation, Portland
Evans Products Co., Coos Bay
Forest Fiber Products Co., Forest Grove
J. Neils Lumber Co., Portland
Oregon Lumber Co., Baker
West Coast Lumberman's Assn., Portland

PENNSYLVANIA
Blaw-Knox Company, Pittsburgh
Firth Sterling Steel & Carbide Corp., Pittsburgh
Frick Company, Waynesboro
Koppers Company, Inc., Pittsburgh
Perkins Glue Co., Lansdale
United States Steel Homes, Inc., Harrisburg
Wood Metals Industries, Inc., Kreamer, Snyder County

SOUTH CAROLINA
Lightsey Brothers, Miley

TENNESSEE
E. L. Bruce Co., Memphis
Chapman Chemical Company, Memphis
Memphis Hardwood Flooring Co., Memphis
Nickey Bros., Inc., Memphis
Tenn. Products & Chemical Corp., Chattanooga

TEXAS
Wm. Cameron & Co., Inc., Waco
Kirby Lumber Corporation, Houston

VERMONT
Fyles & Rice Co., Inc., Bethel

WASHINGTON
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Deer Park Pine Industry, Inc., Deer Park
Douglas Fir Plywood Association, Tacoma
The Long-Bell Lumber Co., Longview
Simpson Logging Co., Shelton
Weyerhaeuser Timber Co., Tacoma

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The Buckstaff Co., Oshkosh
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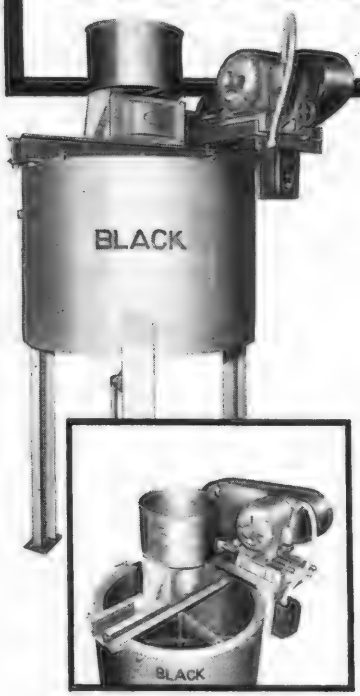
Marathon Corp., Rothschild
Mosinee Paper Mills Co., Mosinee
D. J. Murray Mfg. Co., Wausau
Paine Lumber Co., Oshkosh

ALASKA
Ketchikan Spruce Mills, Ketchikan

CANADA
British Columbia Lbr. Mfrs. Assn., Vancouver, B. C.
Canadian Forest Products Limited, New Westminster, B. C.
Canadian Siempelkamp Ltd., Hamilton,
Dominion Electrohome Industries, Kitchener, Ont.
The Knight Mfg. & Lbr. Co. Ltd., Meaford, Ontario
MacMillan & Bloedel Limited, Vancouver.
A. S. Nicholson & Son, Ltd., Burlington,

THE BLACK BROTHERS
Cold Glue Mixers
FOR POWDERED OR LIQUID ADHESIVES



The Black Brothers stationary cold glue mixers are made in a full range of capacities from 10 to 500 gallons. They are the result of expert engineering combined with years of practical experience in glue equipment manufacturing. Their many features include: (1) Sifter for glue powder (2) *Double agitators which give a beating action resulting in the smoothest possible mixture in the least possible time* . . . see close-up on left (3) Pressure lubrication (4) Cut steel gears . . . hardened and lapped (5) Large quick-acting valve at bottom. Optional equipment includes (1) water jacket (2) variable speed drive. For full information write today for Bulletin 11-1.

The Black Brothers portable motor driven cold glue mixer is made in 2, 5, 7½, and 15 gallon sizes. It has a number of exclusive Black Brothers features such as glue powder sifter, two-way agitation, and specially shaped flat paddles to give a beating action to the agitator. In addition this mixer has a hinged arm that swings up to allow the pail to be inserted or removed. Write for Supplement to Bulletin 11-1.

"If it Is Gluing Equipment—We Have It"

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FPRS NEWS-DIGEST

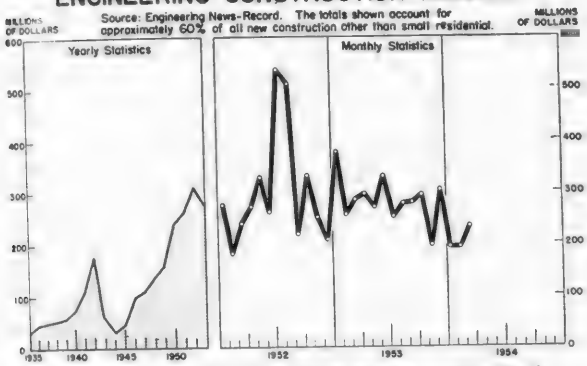
FC :ST PRODUCTS RESEARCH SOCIETY, P. O. BOX 2010, UNIVERSITY STATION, MADISON, WISCONSIN

Vo .ne 4 JUNE, 1954 Number 6

GRAPHIC TRENDS

AVERAGE WEEKLY VOLUME OF
ENGINEERING CONSTRUCTION AWARDS

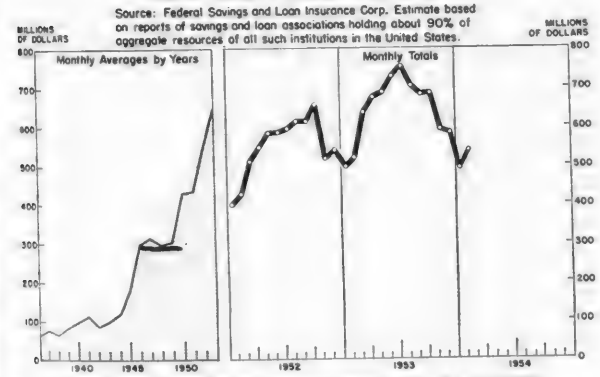
Source: Engineering News-Record. The totals shown account for approximately 60% of all new construction other than small residential.



Average weekly engineering construction awards for 4 weeks of March totaled $233,800,000 compared with $181,650,000 for 4 weeks in Feb. March '53, $280,244,000

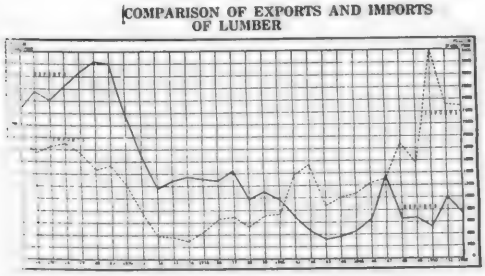
NEW MORTGAGE LOANS

Source: Federal Savings and Loan Insurance Corp. Estimate based on reports of savings and loan associations holding about 90% of aggregate resources of all such institutions in the United States.



New mortgage loans in Feb. totaled $539,358,000. The Jan. figure was $494,859,000 and the Feb., '53 figure was $523,218,000

COMPARISON OF EXPORTS AND IMPORTS OF LUMBER



N.L.M.A.

BUSINESS OUTLOOK

BUREAU OF LABOR STATISTICS, Dept. of Commerce, has revised its total construction figures upwards to $36 billion, which would put '54 about two percent better than originally expected. Surprising house construction figures—indicating close to 1,100,000 starts for the year—account for close to $1 billion in higher-than-expected construction figures.

FURNITURE SALES STILL HAVEN'T PICKED up at a fast pace, but there are suppose to be lots of wait-and-see customers who may shortly become convinced that prices simply can't fall much . . . then there should be a substantial pick-up in sales. Fresh, straight-forward new designs in latest furniture offerings should also stimulate sales.

THERE IS SOME OPINION ABROAD that we are in for a slow but continued cheapening of the dollar. If this is true, and government credit moves lately suggest it may be, the consuming public might well start another buying spurt before their hard earned cash loses more value.

THE SAME STORY APPLIES to the lumber industry. With construction at a high level, and mill shipments still well below last year on a week-by-week basis, inventory replacement buying is in the offing. If the dollar is cheaper by fall, mills simply won't be coming through with the price advantages the retailer may now be holding out for.

NEW PUBLICATIONS

The following publications are available from the Forest Products Laboratory, Madison 5, Wis.

Subject-Matter Index for Dry-Kiln Operators. Raymond C. Rietz. Rpt. No. 1975. Filing of information for future reference requires some sort of an index. Subject-matter designations for library indexing are not detailed enough to cover the range of subjects involved in the seasoning of wood. Therefore, an index has been developed to fit the needs of the Forest Products Laboratory. It has worked well over a period of years and it is thought that it may prove useful to dry-kiln operators, foresters, and others collecting reference information on the seasoning of wood.

Brief Descriptions of Some- Fire-Test Methods Used for Wood and Wood-Base Materials. L. J. Markwardt, H. D., Bruce and A. D. Freas. Rpt. No. 1976. Descriptions of a number of standard fire-test methods are given. A bibliography and photos and/or drawings of test setups are included.

Partial List of Government Publications of Interest to Architects, Builders, Engineers and Retail Lumbermen. Rpt. No. R1091. Publications from various government sources are listed under the headings: fungus defects in forest products; the growth, structure and identification of wood; mechanical properties and structural uses of wood and wood products; glued wood construction; the seasoning of wood; wood finishing subjects; wood preservation; and miscellaneous.

Odoko. (Information leaflet on foreign woods) J. M. Kryn. Rpt. No. 1973. Describes the tree and its distribution and habitat as well as various characteristics of the wood. Mechanical properties are listed in table form and compared to comparable hardwoods, eg. European and American beech. A list of references is included.

Relations Between Gage Retentions and Amounts of Creosote Extractable from Borings Taken from Treated Pine Poles. R. N. Baechler. (reprinted from Proceedings of AWPA) Describes tests in which, when a composite sample of cylindrical borings from treated pine poles in a charge is extracted with toluene, the retention of creosote found in the borings is roughly three-fourths of the retention for the charge as shown by the gage readings. Deviations found are believed to be due mainly to errors in the sample and in the gage readings. Results appear sufficiently promising to warrent further effort to develop a method of checking retention by extraction of borings.

Effect of Heating in Water on the Strength Properties of Wood. J. D. MacLean. (Reprinted from the 1954 Proceedings of AWPA) Results obtained in studies of the effect of different temperatures and different heating periods on the strength properties of small matched specimens of representative softwoods and hardwoods are discussed. Data were obtained on the following strength properties listed in order beginning with the one most affected: (1) work to maximum load, (2) modulus of rupture, (3) fiber stress at proportional limit, and (4) modulus of elasticity.

Production Performance of Equipment Used to Saw Small Logs. C. J. Telford. Rpt. No. 1971. Reports the assembling of production data on several types of mills used to convert small logs approximately 12 inches in diameter inside bark and less. The data are pointed up to give a comparison of efficiencies of the types sample. Various types of equipment included in tests are pictured.

Use and Abuse of Wood. R. F. Suxford and Otto C. Heyer. (Reprinted from Southern Lumberman, March 1, 1954). Gives answers to series of basic questions relative to the use of wood in house construction.

Modulus of Elasticity of Wood Determined by Dynamic Methods. E. R. Bell, E. C. Peck, and N. T. Krueger. Rpt. No. 1977. Presents data from recent studies made to compare results obtained by sonic (dynamic) methods with those obtained from static tests in measuring modulus of elasticity of wood.

* * *

Small Band Mill Plus Small Logs Equals Increased Lumber Yield. David P. Thomas. Bulletin No. 16. Describes layout, equipment and operating efficiency of subject mill. In course of two day study, 596 logs with an average diameter of 11 inches and a length of 16 feet were cut into lumber on the mill's small 5-foot band mill. Average daily production was 30 M board feet. Overrun above net of scale was 39 percent. Lumber grade recovery was good. Production efficiency of the mill, measured in terms of the number of man-hours required to produce one thousand board feet of lumber, was 2.3 for the nine-man crew. Available: Institute of Forest Products, 303 Anderson Hall, University of Washington, Seattle 5, Wash.

Yearbook of Forest Products Statistics, 1953 Edition. Gives figures on production, imports, exports and balances for roundwood, processed wood and wood pulp for more than 100 countries for 1951–52 as collected by the FAO of the United Nations. Presents summaries of wood trade in forest products as well as comparative data on consumption of forest products. Available: International Documents Service, Columbia University Press, 2960 Broadway, New York 27, N. Y. Price $2.50.

Atmospheric Conditions Related to Blowup Fires. George M. Byram. Station Paper No. 35. Describes study of atmospheric conditions that have accompanied a number of blowup fires, and the rather definite picture that results from study. The blowup type fire is described and conditions conducive to it are discussed. Available: Southeastern Forest Experiment Station, Asheville, N. C.

Lumber Grade Yields in the Loblolly-Shortleaf Pine Type by the Southern Pine Log Grades. T. A. McClay. Station Paper No. 37. Paper presents lumber grade percentage recoveries and relative values obtained when applying recently developed grading system at two separate localities in the loblolly-shortleaf pine type. The log grading system provides a means by which the quality of southern pine logs as expressed by 1 yard lumber grade recovery or dollar value per thousand board feet may be estimated. Available: Southeastern Forest Experiment Station, Asheville, N. C. (A more complete discussion of log grades entitled "Interim Log Grades for Southern Pine" is also available.)

Defects in Hardwood Veneer Logs: Their Frequency and Importance. E. S. Harrar. Station Paper No. 39. This report is the first phase in a projected program of study and research which should result within several years in suitable log grade rules for southern hardwood species used in the manufacture of veneer. The present report covers studies of abnormalities that can be seen on the surface of the logs such as bumps, knots, and bark distortions and correlates the occurrence of the and correlates the occurence of these imperfections with the quality of veneer that is produced from the log. It also covers the abnormalities observable on the ends of the logs, especially when these are not revealed on the log surface, and correlates these with veneer quality. Available: Southeastern Forest Experiment Station, Asheville, N. C.

1954–55 FPRS EXECUTIVE BOARD

1954–55 FPRS Executive Board as seen at Grand Rapids meeting includes, seated, left to right: R. D. Pauley, past president; Ralph H. Bescher, vice-president; Lester J. Carr, president; and Moss B. Christian, president-elect. Regional Board Members, standing, left to right, are: John D. Ritchie, Northwest; W. Jeter Eason, South–Central; Frank T. Parrish, North–East; J. Alfred Hall, North–Central; and E. S. Harrar, Southeast. Ray E. Shreck, Southwest Regional Board member, was not present during the picture taking.

FPRS Executive Board Meets

Both preceding and following the official events, the Executive Board met for sessions of some seven and four hours. Among principal actions affecting the membership, the Board voted to proceed with completion of plans for a new Executive Office building in Madison, Wis. The secretary was instructed to exercise an option on a 100-foot wide lot located at the west edge of the University of Wisconsin campus, and near the U. S. Forest Products Laboratory. The architects have been instructed to draw up working plans and bill of materials. It is anticipated that financing of the new building will be met through current operating income plus reasonable assistance in the form of materials, etc., from forest products companies.

The possibilities for our 1957 and 58 national meeting locations were referred to a committee composed of Frank Parrish and Ralph Bescher.

Pres. Carr announced committee chairman appointments. 1955 national nominating committee, K. G. Chesley; 1955 technical program, M. B. Christian; Membership, F. Parrish; Finance & Budget, M. B. Christian; Publications, Edw. Locke; Constitution, By-laws, and Section boundaries, E. S. Harrar; Building Committee, W. J. Eason; Subject Matter Committee Coordinator, R. H. Bescher; Credentials, R. D. Pauley. Meeting chairmen for '55 and '56 are named elsewhere.

Carr also appointed or reappointed the following committee chairmen: Wood Machining, L. A. Patronsky; Wood Preservation, Bill Darwin; Wood Drying, Leif Espanas; Logging & Milling, Fred Simmons; Packaging, Ken Kruger; Wood Composition Board, George Marra; Education, Alex Panshin; Glues & Gluing, Alan Marra; Wood Finishing, E. Sig Johnson; Quality Control, Chuck Latimer; Chemical Utilization, Reavis Sproull; Veneer and Plywood, H. Fleischer and J. Bethel; and Marketing, Phil Creedon.

The next two executive board meetings will be held in Denver, Brown Palace Hotel, Sept. 20, 21; and in Madison, Edgewater Hotel, March 17 and 18.

INDUSTRY NEWS

Forest Biology Research

Some 300 acres of the Valhalla, N. Y., property of the John A. Hartford Foundation has been leased to the Yale University School of Forestry for a vast new program of research and education in forest biology.

The Foundation, founded by the late John A. Hartford who was President of the Great Atlantic & Pacific Tea Co., will also support the new science project with annual grants to Yale for the next 15 years.

The announcement was made by President A. Whitney Griswold of Yale and President Ralph W. Burger of the Foundation.

The grants will be used by Yale to add nine new scientists to its forestry faculty, and to provide for research and training of graduate students in forest biology. Headquarters for the research section will be at Valhalla, near White Plains, N. Y., while the instructional program will be centered in New Haven.

George A. Garratt, Dean of the Yale School of Forestry, in outlining plans for the program, pointed out that "the generous grant of The John A. Hartford Foundation represents an act of philanthropy without parallel in the history of forestry science.

"During recent years the practice of forestry in America has expanded so rapidly that it is fast outgrowing its scientific basis. These grants will support a long-needed attack on biological problems which must be solved if American forests are to become a permanently productive segment of our national economy."

He explained that the forest biology program will cover such major areas of study as tree physiology, xylology (the study of wood), forest soils and insects, as well as the genetical and meteorological aspects of forest production. The Valhalla project represents the greatest expansion in the work of the Yale School of Forestry since it was established in 1900.

"The main emphasis of the new undertaking will be on unlocking the secrets of wood production, which is the central objective of forestry," Dean Garratt said.

The annual grants include five major fellowships for advanced students working for Ph.D. degrees in forest biology. These men will also serve as assistants on research projects.

Damtoft Honored

A degree of Doctor of Forest Science was bestowed upon Walter J. Damtoft, assistant secretary and director of The Champion Paper and Fibre Company's General Woods Department, during the 65th annual commencement program at North Carolina State College, Raleigh, N. C. Majoring in forestry at Yale University, Mr. Damtoft was with the US Forestry Service prior to his association with Champion Paper, dating back to 1920 when he became the firm's chief forester.

The Champion Paper and Fibre Co. is an F.P.R.S. supporting member.

Foxboro Appoints New Training School Director

Mr. W. H. T. Furry has been named Director of the Training and Educational Division of the Foxboro Company, Foxboro, Mass., manufacturer of industrial instrumentation, succeeding Mr. Malcolm B. Hall who recently completed 40 years of service with the firm.

'53 Wood Preservation Facts and Figures

More than 300 million cubic feet of wood was treated with preservatives in 1953. This is a drop of 5 percent from the amount treated in 1952, according to preliminary estimates made by the U. S. Forestry Service in cooperation with the American Wood Preservers' Ass'n. The report covers treatment by preservatives such as creosote, coal-tar, petroleum, pentachlorophenol, and chromated zinc chloride. Principle decreases were in treatment of crossties, poles and lumber, piling and wood blocks. Crossarm treatment increased 67 per cent. Use of coal-tar, creosote and petroleum dropped 9 percent from 1952, use of penta increased 8 percent . . . from May 16 issue, What's Happening in Forestry.

SECTION NEWS

Spring Meeting, Pacific Northwest Section

More than 100 members and guest attended the two-day spring meeting of the Pacific Northwest Section at Aberdeen, Wash., May 17, 18. George Russell, West Tacoma News Print Co., gave an interesting talk on "The Plywood Industry in New Zealand and New Guinea", discussing particularly the 300,000 acre plantation of "Pinus radiata", a pine transplanted from California. This pine thrives in New Zealand and grows very fast. Samples were shown with two rings to the inch.

It was decided to hold the fall meeting on October 25–26 at Corvallis, Ore. The regular section meeting will be the first day, with plant tours and the hardboard session on the second day.

Inland Empire Section to Meet at Missoula, Mont.

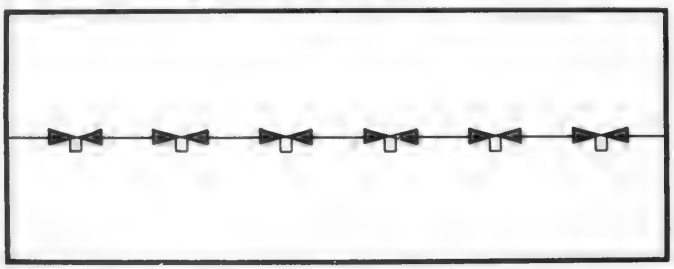
The Inland Empire Section has scheduled a two-day meeting on July 15–16. A smoker and buffet supper will start off the meeting the evening of Thursday, the 15th. Friday morning will be devoted to a short business session and presentation of technical papers. Field trips to sawmills and other plants in the area will be made Friday afternoon.

A special feature planned for the meeting is the attendance of FPRS national president Lester J. Carr, Sacramento, Calif.

Papers to be presented include: Grade Recoveries in Engelmann Spruce, by C. J. Warren, Intermountain Timber Co.; Designing a Small Sawmill, by E. C. Wert, Thompson Falls Timber Co.; Conversion of the U. of Montana Steam Plant from Coal to Hog Fuel and Sawdust, W. H. Rambo, consulting engineer; New Methods in Packaging and Handling at Bonner Mill, T. S. Veazey Anaconda Copper Mining Co.; and The New Sawmill of the Diamond Match Co., Art Nelson.

YES, an old-time patent has expired!

In 1934, a patent was granted to Forrest Cobb of Moore Dry Kiln Co., covering a dry kiln, like this:



Only a few of these kilns were built, for a very good reason—

A later MOORE development—the Longitudinal Shaft Moore Reversible Cross-Circulation Kiln—proved superior and offered undeniably greater advantages:

(1) Faster and more uniform circulation through each sticker course *(It's the air across the lumber that does the drying)*

(2) Lower power consumption for equal volume of circulation

(3) One motor and drive located outside kiln operates entire fan system *(Electric motors and wiring should not be subjected to inside kiln conditions)*

The Moore Cross-Circulation System has been universally adopted by the industry—proven by over 7,000 Moore Cross-Circulation Kilns in daily operation.

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EMPLOYMENT SERVICE

Employment Wanted

No. 229 Young man graduating from the University of Minnesota in January 1955 seeks leads for training in sales or furniture production work. Age 21.

No. 230 Young man graduating in Wood Engineering from State University of New York in June desires employment in sales, either lumber or plywood. Also interested in research and development in the glues and plywood field. Age 21.

No. 231 Chemical engineer: broad background in wood research; course fiber processing, structural laminates, molded plywood, cellular core materials, fiber microscopy, original research in wet process and resin bonded hardboards. 5½ years industrial experience, 1 year managing 30 ton foreign insulation board plant. Have initiated and led product development programs.

No. 232 Man in Midwest seeks position in pulpwood production or pulp research for pulp and paper companies using cottonwoods, aspen, or southern hardwoods. Has Master's degree in forestry and wood technology. Has experience in industry and research positions. Age, 35.

No. 233 Will graduate in August from the University of Florida with MSF in wood technology. Limited logging and retail lumbering experience. Would like position in wood utilization plant, especially interested in research. Prefer South. Age, 28.

Positions Offered

No. E 152 We need an experienced Millwork Superintendent to manage our architectural millwork manufacturing department. Must know all phases of manufacturing including machinery, detailing, and methods. Salary open. Advancement excellent.

FPRS SECTION OFFICERS

(Continued from page 8-A)

Inland Empire Section

Chairman—J. H. Leuthold, Deer Park Pine Industries, Deer Park, Washington.

Vice Chairman—E. E. Wert, Thompson Falls Lumber Co., Thompson Falls, Montana.

Secretary-Treasurer—T. S. Veazey, Anaconda Copper Mining Company, 10 E. Quartz Street, Butte, Montana.

Trustees—M. G. Beale, Lincoln Lumber Co., Lincoln, Washington; L. V. Brown, Northwest Timber Co., Peyton Bldg., Spokane, Washington; L. R. Pugh, Pres., St. Maries' Lumber Co., St. Maries, Idaho.

Midwest Section, '54

Chairman—Carl J. Binner, Morgan Company, Oshkosh, Wisconsin.

Vice-Chairman—Wayne Lewis, U. S. Forest Products Laboratory, Madison, Wisconsin.

Secretary—Ed. R. Rutledge, Jr., Algoma Plywood & Veneer Co., 612 Fifth St., Algoma, Wisconsin.

Trustees—George Stanley, Chicago, Illinois; Forrest Beil, Clinton, Iowa; Ted Connelly, Chicago, Illinois; Ralph Casselman, Oshkosh, Wisconsin; Jack Koellisch, Chicago, Illinois.

Northern California Section

Chairman—James C. Rowney, Rowney Machinery Co., 600–16th Street, Oakland, California.

Vice Chairman—E. P. Ivory, Ivory Pine Co. of California, Box 116, Dinuba, California.

Secretary-Treasurer—Homer N. Stephenson, Sacramento Box & Lumber Co., P. O. Box 1282, Sacramento 6, California.

Trustees—Raymond Berry, V. P., Scott Lumber Company, Inc., Shasta County, Burney, California; Arthur C. Horner, Timber Engineering Co. of Cal., 4314 California St., San Francisco 18, California.

Ohio Valley Section, '54

Chairman—Carl Trinkle, The Baldwin Company, 1801 Gilbert Ave., Cincinnati 2, Ohio.

Vice Chairman—D. B. Frampton, Jr., Baker Wood Preserving Co., Columbus, Ohio.

Secretary—R. M. Garratt, Gamble Brothers, Inc., Louisville, Kentucky.

Treasurer—Russell W. Green, Union Furniture Company, 210 W. George Street, Batesville, Indiana.

Trustees—Robert Foot, New Albany, Indiana; William Lakamp, Cincinnati, Ohio.

Pacific Northwest Section

Chairman—Walter C. Ring, Long Bell Lumber Company, Longview, Washington.

Vice Chairman—H. R. Evans, Plywood Research Foundation, 620 East 26th St., Tacoma 4, Washington.

Secretary-Treasurer—Dr. J. R. Stillinger, Oregon Forest Products Laboratory, 17th & May Streets, Corvallis, Oregon.

Trustees—John B. Armstrong, 810 W. Hastings St., Vancouver 1, B. C., Canada; Robert P. Conklin, Cascades Plywood Service Corp., 1016 Public Service Bldg., Portland 4, Oregon.

Pacific-Southwest Section, '53

Chairman—John R. Barnes, Moisture Register Company, 133 North Garfield Avenue, Alhambra, California.

Vice Chairman—Arthur Koehler, 1969 Thayer Avenue, Los Angeles 25, California.

Secretary—Axel V. Pedersen, 3631 W. Vernon Avenue, Los Angeles 8, California.

Treasurer—E. S. Feldman, Furniture Mfrs. Assn. of Southern California, 2155 E. Seventh Street, Los Angeles, California.

Trustee—Harold W. Jones, Los Angeles, California.

Upper Mississippi Valley Section, '54

Chairman—William A. Kluender, C. & N. W. Railway System, 275 E. 4th Street, St. Paul, Minnesota.

Vice Chairman—Fred Loveland, Fred Loveland & Associates, Route 1, Chippewa Falls, Wisconsin.

Secretary—Ortie LaVoy, Weyerhaeuser Timber Sales Company, First National Bank Bldg., St. Paul, Minnesota.

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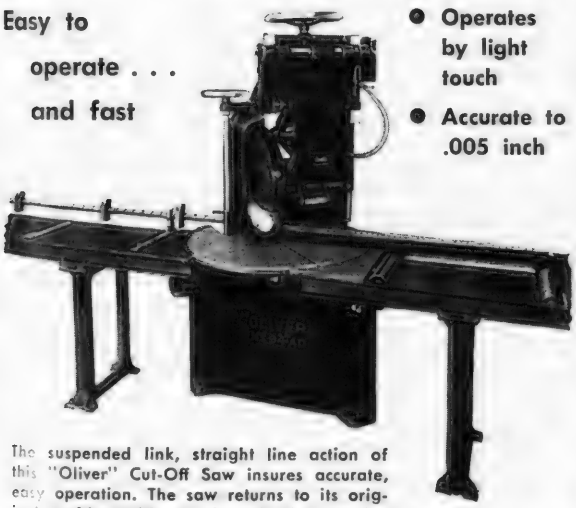
"Oliver" Cut-Off Saw

CUTS OFF SQUARE OR ANGLING

Easy to operate . . . and fast

- Operates by light touch
- Accurate to .005 inch



The suspended link, straight line action of this "Oliver" Cut-Off Saw insures accurate, easy operation. The saw returns to its original position without rebound. The machine swivels to make angle cuts of 45° to right, 15° to left. It is compact—can be placed close to wall. Saw table has automatic cut-off gauge and ball bearing steel rollers. Also available for making only square cuts. *Write for Bulletin 94-AD.*

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Established 1890 GRAND RAPIDS 2, MICHIGAN

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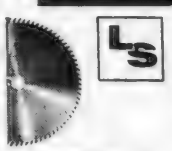
"Universal" design works wonders on all types of cuts



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Dealer and Jobber Territories Still Available. Write for Information Today.

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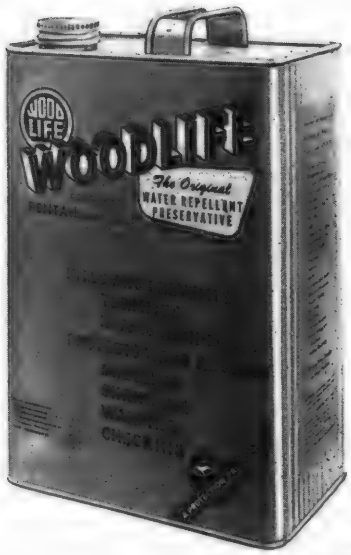
More than just a preservative



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Protection Products
MANUFACTURING COMPANY
Since 1921
Dept. C Kalamazoo, Michigan

LET'S HELP THE WOOD INDUSTRY

(Continued from page 9–A)

(4) Reinstatement of Ex-Members. This group offers a fine opportunity to sell them the idea of returning to our fold. In fact, we have noted lately how easy it is to induce them to become a member again. In some cases it is so easy, we *should* allow only ½ value in our standing!

(5) Student Memberships Are Important. One of our strongest F.P.R.S. membership groups are in the education field. Probably we have a greater percentage of college and university wood tech., utilization and forestry instructors as F.P.R.S. members than any other single group. They realize the value that a membership offers.

During the next year we expect National will make even a more attractive offer to students in that a calendar year membership will coincide with the school year.

Remember, many of these students on graduation will be employed by the wood industry and will swing into a full F.P.R.S. membership classification.

(6) Every Section Meeting Should Stress New Membership. At every section meeting there are always some non-members attending (at least there *should* be quite a lot of them) and here is the ideal chance for the section membership chairman to establish a "Membership Booth" and really do a job. This is felt to be so important that a directive will be issued that National set this in motion as an example at all future National meetings. Let's make sure that each section does it at every meeting and gives it a prominent spot at the meeting hall entrance.

This is but a brief outline of our membership objective and initial plan of action for the coming year. There really is a lot of satisfaction in bringing in a new member. He invariably becomes your friend. You also gain a wider acquaintance and perhaps a valued contact. He does the same, but many times over, as he meets other F.P.R.S. members.

Just Published!

Forest Products Research and Industries in the United States

by W. W. VAROSSIEAU, Ph. D.
Expert for Wood Technology of F.O.A., United Nations

A comprehensive handling of the subject matter, the book is divided into four parts: introduction; the results of visits to forestry operations; contacts made with forest products industries and research laboratories; and summary and conclusions. Considerable attention is paid to research, as well as the organizational aspects of forest products industries, research and education.

The work is designed to appeal to specialists in the field as well as the layman interested in the overall picture of the wood industries of the United States. Definitions of many technical terms are included. The volume contains more than 1,100 references, 98 figures, 101 tables, and 63 photographs.

The author is a graduate of the University of Leiden and was a technologist in the Forest Products Division of the National Council of Applied Scientific Research in the Netherlands. He is currently an Expert for wood technology of F.A.O. United Nations and is assigned to Iran as an assistant professor of wood technology.

726 pages **illustrated** **$12.00**

To FPRS members $10.80

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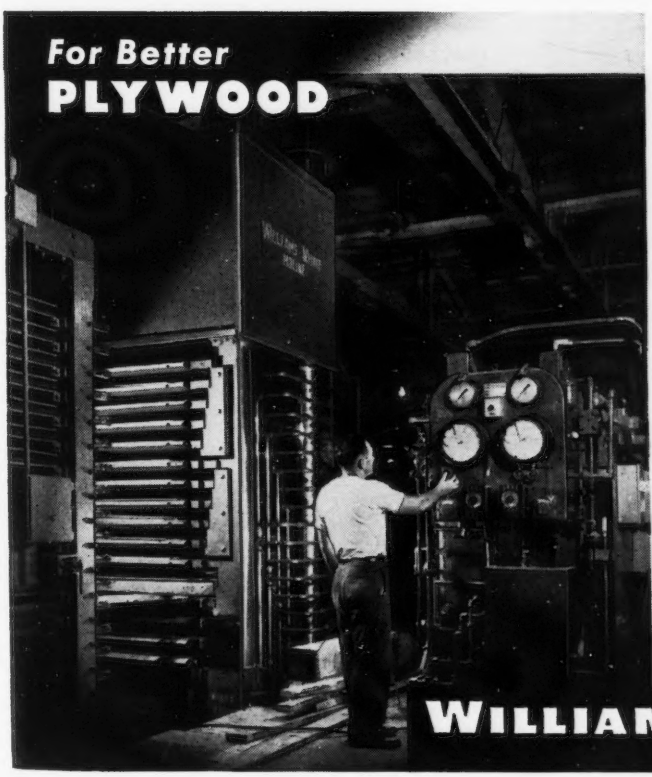

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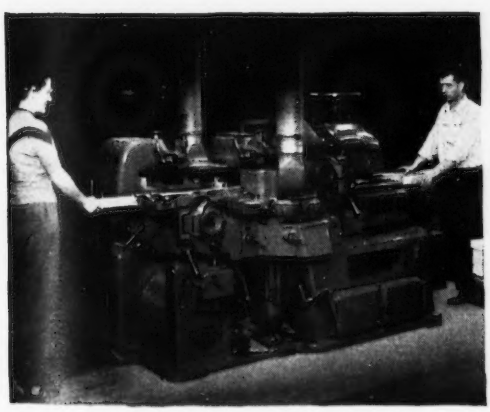

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GRAND RAPIDS·2·MICHIGAN

March 18, 1953

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Gentlemen:

Early this year, we installed one of your No. 276 Heavy-Duty High Speed Electric Moulders. We thought you might like to know how we are getting along with this machine.

Here at Imperial, we manufacture a complete line of high grade tables, and the moulder work must be as nearly perfect as possible to reduce our sanding and fitting operetions. With the addition of this Mattison No. 276, the quality of our moulded work has improved substantially while our costs have gone down.

Our operators find this Mattison No. 276 very easy to set up, due to the accessibility of all the adjustments and controls. Vertical and cross adjustments of the cutterheads are made positively and quickly, and the hand locking wrenches which are attached to the machine simplify setting of the guides. Another feature is that it "stays put", which is no doubt due to the rigid construction, precision manufacture, and advenced engineering design. The outboard bearings eliminate vibration in heavy cuts, and we believe that any high speed moulder spindle should have an outboard bearing.

We are confident that this machine will continue to perform efficiently for a great many years.

Yours very truly,

IMPERIAL FURNITURE COMPANY

A. F. Christy

A. F. Christy
Plant Manager

- Imperial Furniture Company's reputation for building a high quality line of tables is in a good measure due to precise fabrication methods which insures consistently accurate results and proper fitting of all parts. Mr. A. F. Christy, Plant Manager of Imperial, has been around the woodworking industry for a good many years and knows what he wants and has to have in the way of production and accurate results. The above letter telling of his experience with the Mattison 276 Moulder is an example of what this machine is doing for a good many others. For complete information on the Mattison 276 High Speed Electric Moulder, ask us to send you our latest free circular.

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needs your help in today's competition.

You are already assisting him with lower prices and better terms? — But can't you do better?

Are your products competitive enough or are you losing your customer to the plant with modern equipment which undersells you because of cheaper production cost and gives better quality to boot?

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